THURSDAY, MAY 23, 1889.

THE NEW TECHNICAL EDUCATION BILL.

AFTER the storms which have wrecked so many previous attempts to deal with the question of technical education, it is no less surprising than gratifying to find that on Wednesday, May 8, Sir Henry Roscoe's Bill, representing the views of the National Association for the Promotion of Technical Education, slipped through the second reading stage in less than a minute, with no opposition and amid general cheers. If would be too much to expect that the same easy course lies before the Bill in Committee, but at least it may be said that we are much nearer the settlement of this vexed question than we seemed to be a month ago.

The Bill itself, which we reprint elsewhere, does not differ materially from its predecessor of last year—we mean the Bill introduced last year by Sir Henry Roscoe, not the hapless measure drafted by the Government. There is, indeed, an alteration in the definition of technical education, which now includes, besides instruction in the branches of science and art named in the Science and Art Directory, the working of wood, clay, metal, &c., commercial subjects, and "any other subject applicable to the purposes of agriculture, trade, or commercial life and practice, which may be sanctioned by a minute of the Department of Science and Art made on the representation of a School Board or local authority that such a form of instruction is suited to the needs of its district." This is an improvement on last year's definition, which gave the initiative in this matter to the central Department instead of the local authorities. The more freedom that is given to localities to adapt their scheme of technical instruction to the diverse needs of their own industries the better.

But the Bill is essentially unaltered, and it ought to meet with the same approbation from friends of education as greeted its predecessor. It is, like all the measures that have been drafted, an enabling Bill; that is to say, it gives powers to localities to provide technical instruction if they think fit. The Bill deals with the case both of elementary and secondary schools. Technical instruction given in the former will be provided by the School Board, and a school will not cease to be a public elementary school by reason of technical instruction given therein. If, however, a School Board fails to do its duty in the matter, the local authority (*i.e.* the County, District, or Borough Council, or the Urban Sanitary Authority, as the case may be) may step in and make the requisite provision themselves. In the case of higher technical instruction, provision may be made either by the School Board or, except in the case of London, by the local authority. Provision is made for the payment of fees of deserving students, the establishment of scholarships, grants for laboratories, apparatus, museums, libraries, &c. Grants may be made to the higher technical schools by the Science and Art Department, and to elementary schools giving technical instruction by the Science and Art Department, or the Education Department, or both.

The Bill was allowed to pass the second reading unchallenged only on the understanding that certain alterations should be made in Committee. Until the Government amendments are put on paper, it is hard to give an opinion as to the future chances of the measure. It would of course be out of the question to try to revive the clause of the last Government Bill compelling School Boards either to abstain from providing techn'cal instruction altogether, or to make the same provision for voluntary schools as for schools under their own management. It ought not, however, to be difficult to arrange a satisfactory compromise, and so remove what is undoubtedly a defect in the present measure as it stands, viz. the absence of any provision for the large majority of children who are educated in denominational schools.

It would, indeed, be pitiable if the settlement of the question were again postponed owing to the endless difficulty of the relation between Board and voluntary schools. After all, it should be remembered that by far the most important part of technical instruction necessarily falls within the realm of secondary, not of elementary education. The ground may be prepared in the primary school, but that is nearly all. In our opinion, therefore, the most important clauses of the Bill are those dealing with non-elementary schools, and at all costs these must be preserved, and, if possible, extended; for, as we read the Bill, it is doubtful whether they give the local authority the requisite powers to build new technical schools. This, however, is a matter which can easily be set straight in Committee.

We do not wish to undervalue the part of the Bill dealing with elementary schools. It is most undesirable that a School Board that wishes to build a workshop, or provide tools for manual training, should continue to run the risk of surcharge by the auditors, and it is right that the work of the so-called higher elementary schools should be formally recognized, and established on a satisfactory basis. But if there are any who expect, as a result of the measure, that a system of distinctively technical instruction will be introduced wholesale into our elementary schools, they are destined, in our opinion, to be disappointed.

We note with pleasure that the present Bill is not hedged round by the cumbrous and harassing restrictions which disfigured the Government Bill of last year. There is no requirement of a poll, no restriction in the amount of the rate; and, above all, no clause restricting technical instruction in elementary schools to children in the sixth and seventh standards. Of all alterations that may be proposed, an amendment embodying the last-named restriction would, in our opinion, be the most disastrous. It would at once cripple the work of the higher elementary school, and destroy science as a class subject and (in the fifth standard) as a specific subject throughout our elementary school system. The representatives of the Technical Education Association will doubtless be on the watch to see that no sinister alteration of this kind is introduced, for it would virtually convert the Bill into a measure for prohibiting the provision of technical instruction throughout the greater part of the elementary school course.

There are one or two criticisms which we may offer on the measure as it stands. In the first place, it does nothing for girls—for instruction bearing on domestic economy can hardly be brought under any of the heads enumerated in Clause 11. This

objection might be met by slightly extending that clause so as to include cookery, laundry work, &c. Another flaw is the omission to provide expressly for Imperial grants other than payments on results of individual examination. It is true that the Bill leaves the mode in which such grants shall be made to the discretion of the Science and Art Department, but something more definite than this is required. It would be a great mistake if payments for technical instruction were made on results, like the present Science and Art grants; they ought rather to bear a certain proportion to local contributions, and a clause to this effect should, if possible, be embodied in the Bill. Lastly, why should School Boards and local authorities be required to confine any entrance examination which they may institute, to reading, writing, and arithmetic?

In spite of these minor defects in matters of detail, the Bill as a whole ought to meet with the hearty approval of the public, and we trust no stone wi l be left unturned to secure that it shall be passed into law this session. Another year's delay would be most disastrous, as it would have the effect of paralyzing local activity, especially in those centres which have already prepared schemes and collected funds for technical schools, but are waiting year after year to see what form legislation on this subject will take.

A TEXT-BOOK OF HUMAN PHYSIOLOGY.

A Text-book of Human Physiology. By Dr. Austin Flint. Fourth Edition. (London: Lewis, 1888.)

THE present edition of Dr. Flint's "Human Physiology" is a capital manual of the subject. The book has been re-written from the third edition, which was published nine years ago. As might have been expected from the author of the previous work, the style of the text is always clear and eminently readable. Upon the whole the selection of the matter is good, and the illustrations are almost without exception excellent. Detailed description of apparatus and of methods of experiment has been excluded as unsuited to the character of the book. In the same way digression into the laws of physical and chemical science has been avoided as far as possible, on the ground that such knowledge is already within the possession of the student of physiology, or that to obtain it he can turn with advantage to special treatises.

Amid much that is praiseworthy in the work, one may single out some points for especial commendation. The brief historical introductions to certain chapters are of marked excellence, and notably the sketch relating the progress in our knowledge concerning the functions of the heart and blood-vessels. The discussions of the terms hunger and thirst, and of the value of the various constituents of the urine as indices of the general metabolism of the body, are exceedingly full and satisfactory. Very interestingly given, too, is the account of the uses of water and inorganic chemical substances which pass through the organism; and the probability of the formation of a considerable amount of water within the organism during severe muscular exercise is related with striking vigour and force of argument. As its title implies, the volume is devoted particularly to the physiology of man, and the portion dealing with the special mechanisms for voice and speech is exhaustive. The chapters upon the cranial nerves, upon sight, and upon hearing, are perhaps, upon the whole, the best in the entire volume. The illustrations to these chapters are particularly deserving of praise.

In a science developing with such rapidity as of late years physiology has done, peculiar difficulties stand in the way of furnishing a text-book that shall pretend to some degree of completeness, and shall at the same time avoid statement of all that is not absolutely worthy of credence. Dr. Flint has to a great degree succeeded in accomplishing this difficult task. But he has done so somewhat at the expense of matter that might, we think, have been introduced into his text-book with advantage. One finds no definite mention in his work of rhythmic contractility as a function of the fibres of the cardiac muscle *per se*, apart from nervous connections they possess. There is no adequate discussion in this manual, consisting of nearly 900 pages, of the phenomenon of inhibition as an exhibition of temporary diversion of cell-activity into channels of anabolism. When treating of uric acid the writer is silent as to the synthesis from urea and glycocoll, although that fact throws a flood of light upon the origin of the acid in the animal body. A long paragraph is devoted to the pineal gland, and finally the remark is made that in structure it resembles the ductless glands; surely such a suggestion is worse than worthless, in view of the discovery of its relation to the dorsal median eye of Sphenodon.

On the other hand, when writing of the superficial and deep reflexes, no hint is given of any doubt as to the truly reflex nature of the latter. The balance of evidence is decidedly in favour of the patellar jerk being really of the nature of a reflex, yet an unqualified statement on so important a subject is scarcely fair to the student.

In so excellent a chapter as that on sight, it is disappointing to find hardly one word of mention of the phenomena of colour-sensations. The Young-Helmholtz theory is not alluded to, much less any rival hypothesis such as that of Hering. One hears nothing of three primary sensations of colour, or that colour-blindness is most frequently a defect for the rays of the longer wave-lengths. In a physiological work treating especially of man, this ought not to be the case. We are not so poverty-stricken in our knowledge of the functions of the semicircular canals as Dr. Flint would let his reader imagine. No adequate description is given of the symptoms which appear when they are separately injured No adequate representation is made of the views of the long series of more recent workers on the subject. In the statement of the motor-paths by which nervous impulses arrive at the urinary bladder, no reference is made to the sacral spinal nerves, although the contraction brought about through sympathetic channels is incomparably weaker than that effected along the former route. One must add here, however, that the diagram, from Küss, exhibiting the various forms and positions assumed by the organ in question when distended in various degree, is remarkably useful and well-chosen.

Dr. Flint alludes to, rather than describes, the way in which, by partial superposition and fusion of simple contractions, the tetanic contraction of muscle is obtained. He is far too brief upon the matter, especially as he gives it no pictorial illustration in aid of his text. The student whose grains of knowledge on this head had been gleaned

only in the five-lines field that Dr. Flint here allows him, would, one must think, find his garner too empty to satisfy the pillaging of the College examiner. And one sincerely hopes he would. On the other hand, upon the very next page, the significance of the so-called vibration of voluntary muscular contraction is treated in a thoroughly satisfactory way, and in view of extremely recent experiments.

One might have expected, in a text-book of human physiology, to find some description of experiments in hypnotism, or at least some mention of the matter. It is a subject that more and more demands attention from the physiologist and from the physician, and a subject to which the student of medicine can have no better introduction than from the objective, non-metaphysical side from which the physiologist makes his inquiries. One has failed to discover any reference to the subject in this work.

A few instances of curious, and one may say unjust, omission of certain authorities demand mention in a notice of the book. On p. 53 it is related that following ligature of the coronary arteries the heart ceased to beat after a mean interval of twenty-three and a half minutes in six experiments by Erichsen. One would have thought the laborious and all-important research on this subject by Cohnheim and his pupil, Von Schulthen-Rechberg, not to speak of previous work by Panum, and by Samuelson, and Von Bezold, was at least worthy of some comment in the connection, and the more so that the results obtained were so infinitely more significant and valuable than those of the experiments here quoted by Dr. Flint. In describing the endings of nerve-fibres in the fibres of striated muscle, Doyère and Rouget are mentioned, and very properly so; but the name of Kühne does not appear, and nothing is said of the nucleated "sole." The description, too, is illustrated by two figures from Rouget, more than a quarter of a century old. On p. 262 occurs the following:—"It is possible, however, that future researches may show that micro-organisms play an important part in actual digestion, as is foreshadowed in a recent article by Pasteur (August 1887). Pasteur has isolated seventeen different micro-organisms of the mouth. Some of these dissolved albumen, gluten, and caseine, and some transformed starch into glucose." "These observations are very suggestive, and they seem to open a new field of inquiry as regards certain of the processes of digestion." To most readers, these lines would certainly infer that observations of this kind had first been recognized in their full bearing by Pasteur, or that, indeed, the observations of Pasteur were the earliest or the most important of the kind. To do this is to do signal injustice to a large number of investigators, who, possessed of the idea, have obtained experimental evidence of its truth, much more complete than, and several years in advance of, that published by Pasteur. One need only mention the names of Duclaux, Marcano, Hueppe, Miller, Wortmann, Escherich, Bourquelot, Brieger, Wolff; and there are many others.

A minor point on which one is inclined to join issue with Dr. Flint is the terminology he employs. He does not employ the word metabolism, but the notion is expressed by employment of "assimilation," and "dis-assimilation." The latter has a peculiarly uncouth ring. The words "anabolism" and "katabolism" one does not find. To speak of serum albumin as serine; of paraglobulin as metalbumen, and of this last as "dissolved fibrin" is likely to render more confused subjects that are sufficiently so already. It is not usual to spell the name lecithin indiscriminately lecithene and lecethine. Gustation and olfaction are not pretty words.

In the matter of illustrations the volume is thoroughly and artistically equipped. Fig. 64 and one or two more of the same kind are, however, severe blemishes. How, one asks, can the drawing of a dog with a fistulous wound in the body benefit the student? What good purpose can it subserve? The figure is a useless, gratuitous exhibition of what must to every mind be the unfortunate and repulsive accompaniment of physiological research. Intellectual and material boons conferred upon society justify to the full a pursuit of the science in despite of every difficulty of this kind, because those boons can be obtained for it by no other course of action. They do not, however, justify for such a book as Dr. Flint's one single picture such as those referred to.

As was to be expected, the question of the elimination of nitrogen from the body is treated with that pleasant decision and competence that can be assumed only by an author who has himself carried on research in the field of which he is writing. The observations of Dr. Flint upon Weston the pedestrian are seemingly at variance, as he remarks, with those of Parkes, and of Fick and Wislicenus, made upon other persons. The suggestion is valuable that the difference may be explained by the much more strenuous character of the exertion undergone by Weston than by Parkes's soldiers, or by the physiologists who walked up the Faulhorn. Dr. Flint found that the excretion of urea was increased by a walk of 100 kilometres a day for five consecutive days, the walker being upon the same generous diet during as well as before and after the exertion. Fick and Wislicenus during their ascent and for a short time beforehand abstained from all nitrogenous food. They found an actual decrease in the amount of urea excreted in the period of exertion. But in the main result the researches are in accord. They all alike fail to yield evidence of increased degradation of proteids sufficient to account for the increased quantity of energy set free.

In conclusion one has to add one word in praise of the form and typography of the book. It is evident that, as the author says in his preface, "the publishers have spared nothing in the mechanical execution of the work." C. S. S.

GEOGRAPHY IN GERMANY.

Beiträge zur Geophysik: Abhandlungen aus dem geographischen Seminar der Universität Strassburg. Herausgegeben von Prof. Dr. Georg Gerland. I. Band. (Stuttgart: Koch, 1887.)

Bericht über die Entwickelung der Methodik und des Studiums der Erdkunde. Von Prof. Dr. Hermann Wagner. Im *Geographisches Jahrbuch*, 1888. (Gotha: Perthes.)

IN 1886–87 there was much discussion among English geographers about the limits and methods of their subject. The whole matter had been gone into by the Germans a few years before. It is curious to note that

just when we had relapsed into something like silence on the point, and had agreed to put our views to the test of practice, the debate was vigorously revived in the Fatherland. In part this was the effect of the sympathy and of the supply of material for criticism which came across the water, but in the main it was due to Dr. Gerland's striking introduction to the first volume of the Strassburg "Contributions to Geophysics." In the last *Geographisches Jahrbuch* Dr. Wagner sums up both the English and the German discussions, and, though he differs radically from Dr. Gerland's fundamental positions, he gives to his essay the place of honour. The clearness and richness of its style, the closeness of its argument, the extreme and unhesitating views it enunciates, and its author's great experience command attention, and must be the excuse for once more bringing an almost threadbare subject before English readers.

The three propositions which Dr. Gerland aims chiefly at establishing are that geography has to deal not merely with the earth's surface, or even the earth's crust, but with the earth as a whole; that the human element should be shut out entirely from the view of the geographer, and that geography must be a single science characterized by a single method of investigation, the "mathematical-physical" to the exclusion of the "biological-historical." He defines the task of geography as the study of the "interaction between the earth's interior and the earth's surface," of the "interaction of the forces connected with the earth's matter, and the arranging and rearranging—the development—of the earth's matter as a result of these forces;" in a word of "the earth as a whole," the surface being but the expression of the interior. He enumerates five "geographical disciplines"—mathematical geography, geophysics, *Länderkunde*, geography of organisms, history of geography—and of these geophysics is the most important. He regards mathematics, physics, and geology, as the sciences auxiliary to geography, but mathematics as the least dispensable. He agrees with the views expressed in England in 1887, in laying down the difference between geology and geography as consisting not in the objects studied, which are to a certain extent the same, but in the point of view from which they are studied. After comparing the definitions and programmes of geology according to Naumann, Lapparent, Lyell, and Credner, he terms geography the science of the forces of the earth as a whole (*Kräfte der Gesammterde*); geology, that of the structure of the earth's crust (*Structur der Erdrinde*). It should be noted that his *Länderkunde* is purely physical, the "special part of geophysics"; and that his geography of organisms refuses to touch the organism man. He excludes the human element, or, to use Ratzel's term, *Anthropogeographie*, from geography, on the grounds that, while geography is a science auxiliary to history, the converse is not true; that geography would have two methods—the "mathematical-physical-exact" and the "biological-historical-conclusive"; that mastery of the two methods exceeds the power of one man, and that, as an educational discipline, geography loses force and logical cohesion owing to the mixture of the two methods. He assigns anthropogeography to the historian, whose point of view is that of the microcosm, man.

Dr. Gerland claims for geography, as defined by him, that it is a single science, dealing with a homogeneous mass of facts, with one method and a logical unity, making it a true field for the investigator, and of value to the teacher. His essay of fifty-four pages contains a wealth of examples and of neat formulæ which compel admiration; but it is questionable whether he does much good with his chief positions. With Dr. Wagner, we are disposed to think that he exaggerates the importance of his point that the earth *as a whole* is the subject of geography. He keenly combats the view that the surface of the earth, the topographical, is the specific characteristic of geography. Yet surely the burden of what has been recently said, on the part even of those who hold this view, has been that you must not stop short at the defining of relative position, but inquire into causes, and those causes lie largely within the earth. But Dr. Gerland's second position, his uncompromising exclusion of the human element, has more substance. Bold though he is, he has not dared to exclude the geography of (non-human) organisms. Does not his inconsistency here invalidate his programme? All through his essay one fancies there is a certain undertone of contempt for the merely probable results of anthropogeography. But are the results of the investigation of the distribution of animals at best more than highly probable? Are they not attained by the biological-historical-conclusive method? Are they capable of mathematical expression or certainty? Again, is it fatal to geography that it is too much for one man? Is any man equally master of all the methods of any science? Dr. Gerland is hardly fair to anthropogeography. He says, "river and town are heterogeneous conceptions which geography can never bind logically together." Surely a river may be viewed under two aspects—physical and human. It is part of a great circulation beginning and ending in the ocean, and it is an obstacle or an advantage, according to circumstances, to human communication. Lines of human communication and points of human settlement are not heterogeneous conceptions.

But the real seriousness of Dr. Gerland's contention lies in its results in education; indeed here only is it important. You cannot hedge in the original investigator; you cannot forbid him to cultivate the march-lands which sever the different fields of knowledge. You are only entitled to define what you expect of a geographical teacher and text-book. To exclude the human element would be fatal to the early or general learning of geography. None but mathematical specialists have the preliminary knowledge needed for Dr. Gerland's geography. It would be equally bad to have two geographies, one for the schoolmaster, another for the professor, for it is just because the Universities have neglected this subject that the school teaching has been so ineffectual. Logically, mathematical geography should no doubt come first, but a teacher rarely does well to begin his teaching with the first principles of his subject.

H. J. MACKINDER.

OUR BOOK SHELF.

Gleanings from Japan. By W. G. Dickson. (Edinburgh and London: W. Blackwood and Sons, 1889.)

AFTER an interval of twenty years, Mr. Dickson revisited Japan in 1883-84, and in the present volume he gives an account of what he saw. The book contains no very novel

information; so many travellers have lately recorded their impressions of Japan that it would now be hard for a writer to present any part of the subject from a wholly new point of view. Nevertheless, Mr. Dickson's book is one of exceptional interest, for, having already been in Japan, and having carefully studied its history, he knew exactly, on his return, the kind of phenomena which it would be best for him to study. Accordingly, we find in his narrative that he fastens attention chiefly on what is really characteristic of Japanese life, and that he understands how to connect particular facts with the general tendencies of Japanese society. Mr. Dickson was, of course, greatly struck by the enormous changes which had taken place from the time when he had formerly visited Japan, and he adds largely to the value of his observations by steadily comparing and contrasting the conditions which came under his notice four or five years ago with those he had noted twenty years before. About Japanese customs and institutions, so far as they are of native origin, he writes in a kindly and appreciative spirit; and he also finds something to admire in the effort of the educated classes "to advance in Western learning and the acquisition of scientific information." He declines, however, to commit himself to any very decided opinion as to the future of Japan. That she may have serious troubles in store for her he does not dispute; but, if they come, they will, he thinks, spring altogether from internal causes, and he has sufficient respect for her rulers to suggest that they "may have wisdom to avert a crash."

Statics for Beginners. By John Greaves, M.A. (London: Macmillan and Co., 1889.)

To simplify the subject of statics, and to make it attractive at the same time, is by no means an easy task, but the author of this little book has gone far towards succeeding in doing this. With the approval of several experienced teachers, the principle of the transmissibility of force has been discarded in favour of the ordinary method. The parallelogram of forces is deduced from the laws of motion, Duchayla's proof being given as an alternative. The definitions are admirable, and the various proofs are as simple as they well can be.

The examples are progressive and very numerous, typical ones being fully worked out.

The book is admirably adapted to serve as a stepping-stone to the larger treatises.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Structure and Distribution of Coral Reefs.

As I have had no personal experience of coral-reefs, I do not wish to touch more than the literary side of the controversy, but, in regard to this, Mr. Guppy's letter in the last number of NATURE (p. 53) obliges me to call attention to the fact that the "90-fathom reef" which he mentions is not at Socotra, but at Rodriguez. Also that, apart from Mr. Guppy, I found little evidence of "ignorance of the depths in which coral-reefs may form." On the contrary, there appeared to be a remarkable concurrence of testimony on the part of observers that, though occasionally a reef-building species may be found alive at depths greater than about 25 fathoms, this bathymetric limit for the growth of reefs, assigned by the earlier observers, is sufficiently accurate for all practical purposes.

It seems, then, to me that, with the evidence before us, the *onus probandi* of the supposition that a reef may commence at any depth which the exigencies of a particular case require, rests on Mr. Guppy (this done, no theory of coral-reef formation is needed—they may grow anywhere). But, till he can establish this hypothetical but fundamental proposition, Masámarhu Island is a fact for Darwin. T. G. BONNEY.

The Turtle-headed Rock Cod.

A RARE specimen of the turtle-headed rock cod (*Glyptauchen panduratus*) has just come into the hands of Mr. J. Douglas Ogilby, of the Ichthyological Department of the Australian Museum at Sydney. This extraordinary fish belongs to the family of the red rock cods. Not many years ago these fishes (the red rock cod and its allies) formed a part of a most miscellaneous collection of species, which, under the general title of *Triglidæ*, included the true gurnards (*Trigla* and *Lepidotrigla*), the flying gurnards (*Dactylopterus*), and the flat-heads (*Platycephalus*). In 1860, however, Dr. Günther wisely separated these fishes from the *Triglidæ*, which family he broke up into four distinct groups. The first of these, named by him *Scorpænidæ*, is that to which the specimen just captured at Sydney belongs. All the *Scorpænidæ* are carnivorous marine fishes, most of which live at the bottom of the sea, and are generally provided with a powerful armature of the head and fin spines; while many possess skinny appendages on the head and body variously developed, which, owing to their resemblance to the fronds of seaweeds, serve the double purpose of enabling them the more easily to obtain their food, and the more effectually to conceal themselves from their enemies. As they are mostly of a small size, this latter point is evidently of no slight value, because, being slow, lazy fishes, they would, without some such means of protection, be unable to cope with their swifter antagonists. Nature has additionally protected this family by enabling it to vary its coloration according to any change of locality which it may be necessary to make, so as, chameleon-like, to fit itself for adaptation to the various phases of life under which it may be called on to exist. The genus *Glyptauchen*, of which the species just received by Mr. Ogilby is the sole representative, was separated in 1860 by Dr. A. Günther from the Cuvierian genus *Apistus*, for the reception of a fish from King George's Sound, Western Australia, described many years ago by Sir John Richardson under the name of *A. panduratus*. It has since been recorded from Port Jackson (Sydney), and the present specimen comes from Manly Beach, a few miles to the north of Port Jackson.

T.

Atmospheric Electricity.

YOUR correspondent, Mr. C. A. C. Bowlker, will, probably, be interested to learn that an electrical discharge, exactly similar to that which he recently experienced on the Glydyr Fawr (? "Elidyr") was described by the late Dr. Mann, and by Mr. F. G. Smith, in the Quarterly Journal of the Meteorological Society for October 1875.

Mr. Smith was engaged in August 1865 in ascending the Linguard Mountain from Pontresina, when his party was overtaken by bad weather. They reached the summit, however, and found, at one end of the ridge of which it consists, a flag-staff tipped with an iron point, and, at the other, a flat metal disk, serving to indicate bearings. Snow was falling, and nothing was visible except mist, but the "otherwise death-like stillness of the spot was broken by a strange, intermittent noise, resembling the rattling of hailstones against the panes of a window. A careful investigation of the cause of this noise soon made it apparent that it proceeded from the flag staff, and was due to the passage of a continuous electrical discharge from the cloud in which the summit was wrapped."

After a time, the party, although, by Mr. Smith's own admission, "alarmed," held their alpenstocks, points upward, in the air, and, at once, each became conscious of an "electrical discharge passing through him, and causing a throbbing in the temples and a tingling in the finger-ends. The noise was still vigorously proceeding when, after three-quarters of an hour's stay, Mr. Smith and his party left the summit."

I called attention to a somewhat similar phenomenon ("An Engineer's Holiday," vol. i. p. 204), which I experienced on crossing the divide separating Central City from Idaho Springs, Colorado, the height of the ridge being 10,000 feet above sea-level.

There was thunder, and "it was raining, but without lightning, as we neared the divide, when I felt a tickling sensation on the backs of my hands. Presuming that a discharge was taking place between our bodies and the cloud, I tried to increase its intensity by holding my wet umbrella, point upwards, above the waggon. This, at once, produced distinct sensations in the hand and arm, the driver remarking, 'Oh! that's common enough here, though many don't know what it is,

just when we had relapsed into something like silence on the point, and had agreed to put our views to the test of practice, the debate was vigorously revived in the Fatherland. In part this was the effect of the sympathy and of the supply of material for criticism which came across the water, but in the main it was due to Dr. Gerland's striking introduction to the first volume of the Strassburg "Contributions to Geophysics." In the last *Geographisches Jahrbuch* Dr. Wagner sums up both the English and the German discussions, and, though he differs radically from Dr. Gerland's fundamental positions, he gives to his essay the place of honour. The clearness and richness of its style, the closeness of its argument, the extreme and unhesitating views it enunciates, and its author's great experience command attention, and must be the excuse for once more bringing an almost threadbare subject before English readers.

The three propositions which Dr. Gerland aims chiefly at establishing are that geography has to deal not merely with the earth's surface, or even the earth's crust, but with the earth as a whole; that the human element should be shut out entirely from the view of the geographer, and that geography must be a single science characterized by a single method of investigation, the "mathematical-physical" to the exclusion of the "biological-historical." He defines the task of geography as the study of the "interaction between the earth's interior and the earth's surface," of the "interaction of the forces connected with the earth's matter, and the arranging and rearranging—the development—of the earth's matter as a result of these forces;" in a word of "the earth as a whole," the surface being but the expression of the interior. He enumerates five "geographical disciplines"—mathematical geography, geophysics, *Länderkunde*, geography of organisms, history of geography—and of these geophysics is the most important. He regards mathematics, physics, and geology, as the sciences auxiliary to geography, but mathematics as the least dispensable. He agrees with the views expressed in England in 1887, in laying down the difference between geology and geography as consisting not in the objects studied, which are to a certain extent the same, but in the point of view from which they are studied. After comparing the definitions and programmes of geology according to Naumann, Lapparent, Lyell, and Credner, he terms geography the science of the forces of the earth as a whole (*Kräfte der Gesammterde*); geology, that of the structure of the earth's crust (*Structur der Erdrinde*). It should be noted that his *Länderkunde* is purely physical, the "special part of geophysics"; and that his geography of organisms refuses to touch the organism man. He excludes the human element, or, to use Ratzel's term, *Anthropogeographie*, from geography, on the grounds that, while geography is a science auxiliary to history, the converse is not true; that geography would have two methods—the "mathematical-physical-exact" and the "biological-historical-conclusive"; that mastery of the two methods exceeds the power of one man, and that, as an educational discipline, geography loses force and logical cohesion owing to the mixture of the two methods. He assigns anthropogeography to the historian, whose point of view is that of the microcosm, man.

Dr. Gerland claims for geography, as defined by him, that it is a single science, dealing with a homogeneous mass of facts, with one method and a logical unity, making it a true field for the investigator, and of value to the teacher. His essay of fifty-four pages contains a wealth of examples and of neat formulæ which compel admiration; but it is questionable whether he does much good with his chief positions. With Dr. Wagner, we are disposed to think that he exaggerates the importance of his point that the earth *as a whole* is the subject of geography. He keenly combats the view that the surface of the earth, the topographical, is the specific characteristic of geography. Yet surely the burden of what has been recently said, on the part even of those who hold this view, has been that you must not stop short at the defining of relative position, but inquire into causes, and those causes lie largely within the earth. But Dr. Gerland's second position, his uncompromising exclusion of the human element, has more substance. Bold though he is, he has not dared to exclude the geography of (non-human) organisms. Does not his inconsistency here invalidate his programme? All through his essay one fancies there is a certain undertone of contempt for the merely probable results of anthropogeography. But are the results of the investigation of the distribution of animals at best more than highly probable? Are they not attained by the biological-historical-conclusive method? Are they capable of mathematical expression or certainty? Again, is it fatal to geography that it is too much for one man? Is any man equally master of all the methods of any science? Dr. Gerland is hardly fair to anthropogeography. He says, "river and town are heterogeneous conceptions which geography can never bind logically together." Surely a river may be viewed under two aspects—physical and human. It is part of a great circulation beginning and ending in the ocean, and it is an obstacle or an advantage, according to circumstances, to human communication. Lines of human communication and points of human settlement are not heterogeneous conceptions.

But the real seriousness of Dr. Gerland's contention lies in its results in education; indeed here only is it important. You cannot hedge in the original investigator; you cannot forbid him to cultivate the march-lands which sever the different fields of knowledge. You are only entitled to define what you expect of a geographical teacher and text-book. To exclude the human element would be fatal to the early or general learning of geography. None but mathematical specialists have the preliminary knowledge needed for Dr. Gerland's geography. It would be equally bad to have two geographies, one for the schoolmaster, another for the professor, for it is just because the Universities have neglected this subject that the school teaching has been so ineffectual. Logically, mathematical geography should no doubt come first, but a teacher rarely does well to begin his teaching with the first principles of his subject.

H. J. MACKINDER.

OUR BOOK SHELF.

Gleanings from Japan. By W. G. Dickson. (Edinburgh and London: W. Blackwood and Sons, 1889.)

AFTER an interval of twenty years, Mr. Dickson revisited Japan in 1883-84, and in the present volume he gives an account of what he saw. The book contains no very novel

information; so many travellers have lately recorded their impressions of Japan that it would now be hard for a writer to present any part of the subject from a wholly new point of view. Nevertheless, Mr. Dickson's book is one of exceptional interest, for, having already been in Japan, and having carefully studied its history, he knew exactly, on his return, the kind of phenomena which it would be best for him to study. Accordingly, we find in his narrative that he fastens attention chiefly on what is really characteristic of Japanese life, and that he understands how to connect particular facts with the general tendencies of Japanese society. Mr. Dickson was, of course, greatly struck by the enormous changes which had taken place from the time when he had formerly visited Japan, and he adds largely to the value of his observations by steadily comparing and contrasting the conditions which came under his notice four or five years ago with those he had noted twenty years before. About Japanese customs and institutions, so far as they are of native origin, he writes in a kindly and appreciative spirit; and he also finds something to admire in the effort of the educated classes "to advance in Western learning and the acquisition of scientific information." He declines, however, to commit himself to any very decided opinion as to the future of Japan. That she may have serious troubles in store for her he does not dispute; but, if they come, they will, he thinks, spring altogether from internal causes, and he has sufficient respect for her rulers to suggest that they "may have wisdom to avert a crash."

Statics for Beginners. By John Greaves, M.A. (London: Macmillan and Co., 1889.)

To simplify the subject of statics, and to make it attractive at the same time, is by no means an easy task, but the author of this little book has gone far towards succeeding in doing this. With the approval of several experienced teachers, the principle of the transmissibility of force has been discarded in favour of the ordinary method. The parallelogram of forces is deduced from the laws of motion, Duchayla's proof being given as an alternative. The definitions are admirable, and the various proofs are as simple as they well can be.

The examples are progressive and very numerous, typical ones being fully worked out.

The book is admirably adapted to serve as a stepping-stone to the larger treatises.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Structure and Distribution of Coral Reefs.

As I have had no personal experience of coral-reefs, I do not wish to touch more than the literary side of the controversy, but, in regard to this, Mr. Guppy's letter in the last number of NATURE (p. 53) obliges me to call attention to the fact that the "90-fathom reef" which he mentions is not at Socotra, but at Rodriguez. Also that, apart from Mr. Guppy, I found little evidence of "ignorance of the depths in which coral-reefs may form." On the contrary, there appeared to be a remarkable concurrence of testimony on the part of observers that, though occasionally a reef-building species may be found alive at depths greater than about 25 fathoms, this bathymetric limit for the growth of reefs, assigned by the earlier observers, is sufficiently accurate for all practical purposes.

It seems, then, to me that, with the evidence before us, the *onus probandi* of the supposition that a reef may commence at any depth which the exigencies of a particular case require, rests on Mr. Guppy (this done, no theory of coral-reef formation is needed—they may grow anywhere). But, till he can establish this hypothetical but fundamental proposition, Masámarhu Island is a fact for Darwin.

T. G. BONNEY.

The Turtle-headed Rock Cod.

A RARE specimen of the turtle-headed rock cod (*Glyptauchen panduratus*) has just come into the hands of Mr. J. Douglas Ogilby, of the Ichthyological Department of the Australian Museum at Sydney. This extraordinary fish belongs to the family of the red rock cods. Not many years ago these fishes (the red rock cod and its allies) formed a part of a most miscellaneous collection of species, which, under the general title of *Triglidæ*, included the true gurnards (*Trigla* and *Lepidotrigla*), the flying gurnards (*Dactylopterus*), and the flat-heads (*Platycephalus*). In 1860, however, Dr. Günther wisely separated these fishes from the *Triglidæ*, which family he broke up into four distinct groups. The first of these, named by him *Scorpænidæ*, is that to which the specimen just captured at Sydney belongs. All the *Scorpænidæ* are carnivorous marine fishes, most of which live at the bottom of the sea, and are generally provided with a powerful armature of the head and fin spines; while many possess skinny appendages on the head and body variously developed, which, owing to their resemblance to the fronds of seaweeds, serve the double purpose of enabling them the more easily to obtain their food, and the more effectually to conceal themselves from their enemies. As they are mostly of a small size, this latter point is evidently of no slight value, because, being slow, lazy fishes, they would, without some such means of protection, be unable to cope with their swifter antagonists. Nature has additionally protected this family by enabling it to vary its coloration according to any change of locality which it may be necessary to make, so as, chameleon-like, to fit itself for adaptation to the various phases of life under which it may be called on to exist. The genus *Glyptauchen*, of which the species just received by Mr. Ogilby is the sole representative, was separated in 1860 by Dr. A. Günther from the Cuvierian genus *Apistus*, for the reception of a fish from King George's Sound, Western Australia, described many years ago by Sir John Richardson under the name of *A. panduratus*. It has since been recorded from Port Jackson (Sydney), and the present specimen comes from Manly Beach, a few miles to the north of Port Jackson.

T.

Atmospheric Electricity.

YOUR correspondent, Mr. C. A. C. Bowlker, will, probably, be interested to learn that an electrical discharge, exactly similar to that which he recently experienced on the Glydyr Fawr (? "Elidyr") was described by the late Dr. Mann, and by Mr. F. G. Smith, in the Quarterly Journal of the Meteorological Society for October 1875.

Mr. Smith was engaged in August 1865 in ascending the Linguard Mountain from Pontresina, when his party was overtaken by bad weather. They reached the summit, however, and found, at one end of the ridge of which it consists, a flag-staff tipped with an iron point, and, at the other, a flat metal disk, serving to indicate bearings. Snow was falling, and nothing was visible except mist, but the "otherwise death-like stillness of the spot was broken by a strange, intermittent noise, resembling the rattling of hailstones against the panes of a window. A careful investigation of the cause of this noise soon made it apparent that it proceeded from the flag staff, and was due to the passage of a continuous electrical discharge from the cloud in which the summit was wrapped."

After a time, the party, although, by Mr. Smith's own admission, "alarmed," held their alpenstocks, points upward, in the air, and, at once, each became conscious of an "electrical discharge passing through him, and causing a throbbing in the temples and a tingling in the finger-ends. The noise was still vigorously proceeding when, after three-quarters of an hour's stay, Mr. Smith and his party left the summit."

I called attention to a somewhat similar phenomenon ("An Engineer's Holiday," vol. i. p. 204), which I experienced on crossing the divide separating Central City from Idaho Springs, Colorado, the height of the ridge being 10,000 feet above sea-level.

There was thunder, and "it was raining, but without lightning, as we neared the divide, when I felt a tickling sensation on the backs of my hands. Presuming that a discharge was taking place between our bodies and the cloud, I tried to increase its intensity by holding my wet umbrella, point upwards, above the waggon. This, at once, produced distinct sensations in the hand and arm, the driver remarking, 'Oh! that's common enough here, though many don't know what it is,

and others don't notice it.' This man was very nervous about crossing the divide at all while it was thundering, and plainly said if there was lightning he must wait for fair weather."

Possibly, sound might have accompanied this discharge, but the noise of our wheels would have drowned it.

Holmwood, Putney Hill, May 19. DAN. PIDGEON.

Rain-Clouds.

THE rain-cloud which Mr. Abercromby sketches in NATURE of May 2 (p. 12) is often seen in Upper Austria in summer. I have given a rough sketch of these thunder-clouds in the Austrian *Meteorological Journal*, vol. viii., 1873, p. 104.

Vienna, Hohe Warte 38. JULIUS HANN.

THE MUYBRIDGE PHOTOGRAPHS.[1]

MR. MUYBRIDGE is of English birth, a citizen of the Great Republic, and a professional photographer. Long before he applied his knowledge and skill to the subject of instantaneous photography of moving animals and human beings, he had obtained recognition by his work in producing valuable views of Californian scenery, of Panama and the West Indies. In 1872 he made the first lateral photograph of a horse trotting at full speed, for the purpose of settling a controversy among horsemen as to "whether all the feet of a horse while trotting were entirely clear of the ground" at at any one instant of time. It was not until 1877, however, that he conceived the idea that animal locomotion, which was then attracting considerable attention through the experiments of Prof. Marey, of the Collège de France, might be investigated by means of instantaneous photography, with results of value both to the artist and to the naturalist.

Marey's investigations were made by means of elastic cushions, or *tambours*, which were placed on the feet of the moving animal, and connected by flexible tubes to pencils writing on a chronograph. A record of the impact of each foot on the ground was thus obtained, and important information was deduced from these records as to the succession of footfalls and the time-intervals separating them in the various "gaits" of the horse.

Mr. Muybridge proposed to settle this and similar problems once for all by a complete and demonstrative graphic method. He arranged a number of cameras side by side, parallel to the track along which a horse was to be ridden. Each camera was provided with a specially contrived "exposer" (the word suggested by Mr. Muybridge in place of "shutter"), which could be let go by the pulling of a string. The strings connected with the "exposers" were placed across the path of the horse, so that they must be broken by him successively in his passage. At the instant of the breaking of the string, the exposer was brought into play in the corresponding camera, and thus the horse was photographed in a succession of intervals of about 14 inches, representing, according to the rate of progression of the horse, a time-interval of more or less than one-twentieth of a second.

In this way, in 1878, with the wet plates then in use a few sets of horses moving with various gaits were taken by Mr. Muybridge. The results were astonishing and conclusive. They were published at the expense of Mr. Leland Standford, under the title of "The Horse in Motion," and were exhibited in Europe in 1882 by Mr. Muybridge, together with other photographs taken in 1879. The reception which Mr. Muybridge met with on his visit to Paris and London was a great encouragement to him to proceed with his work. Meissonier, the great French painter, was enthusiastic in his admission of the value of the photographs as a guide to the observation required for all true artistic work, and the story goes that a particular attitude of the horse presented by him in one of his best known pictures which had been objected to by the critics as unnatural, was demonstrated by the Muybridge photographs to be perfectly correct. The series of little black *silhouettes*, which were at that time the form in which Mr. Muybridge obtained his pictures, were so contradictory of all preconceived notions as to what were the actual phases of attitude passed through by a trotting or a galloping horse, and so difficult to reconcile with the conventional representations of what is of course a totally different thing, viz. what we see when a trotting or galloping horse crosses our field of vision, that Mr. Muybridge determined on his return to America in 1883 to pursue the subject, and to apply improved methods of photography to the study of the rapid movements of a variety of animals and of man. The new dry plates now made it possible to obtain in exposures of 1/5000 of a second and less an amount of detail which was previously impossible. New automatic methods of registration and exposure were to be employed, larger pictures obtained, and the selected series printed without re-touching by a permanent photogravure process. The funds necessary to carry out this scheme were beyond Mr. Muybridge's own resources, and he for some time failed to obtain the necessary aid from any publisher or scientific institution. A Committee of the University of Pennsylvania thereupon came forward and placed £6000 at Mr. Muybridge's disposal, solely on condition that the first proceeds of the sale of the photographs when ready for publication should be assigned to the reimbursement of this sum. The words of Dr. William Pepper, the Provost of the University, in recording this most worthy action, are remarkable, and ably state that conception of the part of the University in the life of the State which we have so often advocated in these pages. "The function of a University," says Dr. Pepper, "is not limited to the mere instruction of students. Researches and original investigations, conducted by the mature scholars composing its Faculties, are an important part of its work; and in a larger conception of its duty should be included the aid which it can extend to investigators engaged in researches too costly or elaborate to be accomplished by private means. When ample provision is made in these several directions, we shall have the University adequately equipped and prepared to exert fully her great function as a discoverer and teacher of truth."

As a result of the action of the University of Pennsylvania in providing Mr. Muybridge with the means to carry out his experiments, we have a really marvellous set of plates—781 in number—each containing a series of from twelve to thirty pictures representing successive instantaneous phases of movement. About 500 of the plates represent men, women, and children, nude and semi-nude, in successive phases of walking, running, jumping, dancing, bathing, fencing, wrestling, boxing, and other such exercises. The rest of the plates give similar studies of the various gaits of horses, asses, mules, oxen, deer, elephants, camels, raccoons, apes, sloths, and other quadrupeds, as well as of the flight of birds. Many of these photographs have been, this spring, exhibited in London by Mr. Muybridge, projected on the screen by electric light—at the Royal Society, the Royal Institution, the Royal Academy, and the South Kensington Art School. The whole series can now be obtained by those who desire to possess them, and to assist the University of of Pennsylvania by bearing a portion of the expense of their production. Series of not less than one hundred plates are also to be disposed of, and may be seen on application to Mr. Muybridge, who is at present in London.

The interest which these photographs present from the scientific point of view is threefold:—

(A) They, first of all, are important as examples of a very nearly perfect method of investigation by photographic and electrical appliances.

[1] "Animal Locomotion: an Electro-photographic Investigation of Consecutive Phases of Animal Movements." By Eadweard Muybridge. Published under the auspices of the University of Pennsylvania, 1888.)

(B) They have also a great value on account of the actual facts of natural history and physiology which they record.

(C) They have, thirdly, a quite distinct and perhaps their most definite interest in their relation to psychology.

It seems, indeed, that the most interesting problems which are brought before us in the Muybridge photographs of the galloping horse are not so much those of animal locomotion itself as these, viz. how is it that this (which is demonstrated by the photograph to be the actual series of attitudes assumed by the galloping horse) has given rise through the human eye and brain to the conventional representation with outstretched fore and hind legs? Can the conventional representation be justified? If it cannot, what do we really *see* as opposed to what really *is*? What is the objective fact—the brain-picture—as opposed to the objective fact—the sun-picture? for it is the former which the painter struggles to reproduce. Here, in fact, science and art are absolutely united in one common search after truth.[1] On this subject I hope to say more in a subsequent article.

With regard to the method and apparatus employed by Mr. Muybridge in the present series of photographs, it is to be noted that they are different from those employed in 1878–79. As in his earlier photographs, so in the later series, Mr. Muybridge's object was to obtain successive clear and separate pictures. In this respect his method differs altogether from the simpler and much cheaper one used by Marey since the publication of Muybridge's first results. Marey's method is, no doubt, efficient, and in a certain sense sufficient, for the purpose of determining some of the main facts as to the phases of the limbs in locomotion. The object to be studied moves in sunlight before a dark background. A photographic camera faces it. A large disk with one or more openings in it is rapidly revolved in front of the lens. Whilst the opening is passing the lens, the moving object is photographed; then there is darkness in the camera until an opening again passes the lens. The moving object has now a new position, and is photographed anew on the same plate: and so on, again and again, as often as required, or until the object has moved beyond the range of the plate. Thus on the same plate are developed a series of images, readily compared and faithfully depicting phases of the movement studied at definite intervals of time. The advantage of this method consists in the simplicity of the apparatus required; its defect is that with rapidly moving objects the amount of light necessary is not easily obtained together with a sufficiently dark background.

Mr. Muybridge's perfected apparatus consists of three batteries, each of twelve (or more) cameras. One battery is parallel to the track, a second looks up it from behind the moving object, a third faces the moving object. Each camera is provided with a specially contrived "exposer" or shutter (so called) which is "let off" by means of an electric current. The exposure thus given is as small as the 1/5000 of a second. The electric connection is such that in each of the batteries A, B, C, a camera, A1, is exposed absolutely synchronously with cameras B1 and C1. So, too, with regard to cameras A2 B2, and C2, and with the rest up to A12, B12, and C12. Each exposure thus gives a group of three synchronous pictures recording lateral, fore, and hind views of the moving object. The intervals between the exposures of the successive trios of cameras, ABC1, ABC2, ABC3, &c., is determined by the rotation of a wheel carrying a metallic brush in front of a circular plate, on the circumference of which are placed equidistant metal studs, one connected with the wires going to each trio. The circuit is completed by the contact of the metal studs with the moving metallic brush. The wheel can, by a special mechanism, be rotated so that a revolution is effected in one second or in any fraction of a second. During one revolution the twelve studs make contact at equal intervals of time, and twelve groups of three photographs each, exposed for the 1/5000 of a second and separated from one another by one-twelfth of the time occupied by a revolution, are taken. Usually, Mr. Muybridge found it convenient to set the wheel so that it should rotate at such a rate as to give 1/30 of a second between the contact of the twelve studs, but longer intervals were also employed. Behind the track along which the object was made to move was a black screen divided by white threads into squares of about 2 inches to the side. The bright sunlight of the open space was the illuminating agent, no artificial light being sufficiently powerful. A full account of the apparatus will be found by those specially interested in the subject in a book published by Lippincott Company of Philadelphia in 1888, entitled "The Muybridge Work at the University of Pennsylvania—the Method and the Result." Enough has been said here to give an idea of the perfection attained in the apparatus.

With regard to the results, in the form of facts recorded of interest to the naturalist and physiologist, it is not easy to speak in the brief space at my disposal. The branch of inquiry opened out by this method of instantaneous photography is in its infancy, and generalizations of any consequence can hardly be looked for at present. The questions to be answered—the hypotheses which it will be necessary to test—have not yet been formulated. What we have in Mr. Muybridge's published plates is a number of individual studies. By far the most complete investigation is that of the various gaits of the horse, which may be considered as very nearly exhaustive. An interesting generalization which perhaps might have been arrived at without the aid of the camera—but could not have been clearly demonstrated without it—is that the walking gait of all Mammalia is the same, including the quadrupedal crawl of the infant man, and the progression of the sloth as it hangs from a horizontal pole. An apparent exception to this rule is found in the baboon, which instead of extending one pair of "diagonals"[1] simultaneously and then bringing them together beneath the body whilst the other pair is extended, exhibits the simultaneous extension of a lateral pair followed by their approximation whilst the opposite lateral pair are extended. The analysis of various gaits involves many points besides the mere swing of the limbs, the most obvious and important of which are the succession of the footfalls, the weight of impact, and its exact period (which need not coincide with visible contact of foot and ground), the exact mechanical value of the complex stroke given by the limb, and the exact period at which it is applied (which need not altogether coincide with that part of it given by the foot as it leaves the ground). Another factor to be studied is the rotation of the various segments of the limb.

Information and suggestion on these points are furnished by the photographs, but it is by no means to be supposed that it is possible that once for all these problems can be settled by any set of photographs, however elaborate. The turning of the quill-feathers of the bird's wing during the upward movement or recovery of the wing, so that they cut the air instead of pressing it with a broad surface, is one of the prettiest demonstrations which Mr. Muybridge has obtained. That such a movement takes place seems to have been observed by the ordinary man in the remote past, for the word "feathering," applied to the similar movement of an oar in rowing, implies a knowledge of the setting of the feathers in the upward movement of the bird's wing.

[1] Mr. Francis Galton, in NATURE, vol. xxvi. p. 228, has made a valuable suggestion on this subject—which is repeated by Mr. George Snell in the *Century* in 1883—to the effect that the brain-picture consists of a blending of the extreme positions of extension of the hind limbs and the fore limbs, which, although not actually coincident in time, are longest in duration of all the phases passed through.

[1] The "diagonals" are the right fore limb and the left hind limb, and the left fore limb and the right hind limb; the "laterals" are the right fore and hind limbs and the left fore and hind limbs.

Whilst the photographs furnish abundant material for the further study and consideration of the normal movements of a variety of animals and of man, there are some in the series which are especially suggestive of new lines of research. Amongst these are the series illustrating locomotion in man in diseased conditions, such as locomotor ataxia, and lateral sclerosis. A distinct line of scientific inquiry is suggested by those photographs which represent men, women, or children, in the course of movement which is associated with emotion. A new chapter in Mr. Darwin's "Expression of the Emotions" could be written by the aid of some of these series, and a most interesting line of investigation, to be followed up by new photographic analysis, is indicated. Not only is the play of facial muscles connected with the series of emotions of the base-ball player recorded in half a dozen pictures taken between the moment of raising the bat and striking the ball, but in other photographs we have unconscious expression of mental condition exhibited by rapidly transient movements of the whole body. These are especially noticeable in the series of a naked child approaching a stranger in order to offer to her a bunch of flowers, and in the three or four phases of movement of the young woman springing from her bath after she has been unexpectedly "douched" from head to foot with a bucket of ice-cold water.

It is clear enough that the correlation of movements of facial and limb muscles in the expression of emotion can be best studied by such instantaneous photographic series as the Muybridge publication contains; and, as Darwin, with his marvellous insight, showed, such study of emotional states furnishes some of the most important evidence with regard to the relationship of man and animals.

It is no doubt true that the immediate result of Mr. Muybridge's work, from the scientific point of view, is the desire which they evoke to apply this method systematically and experimentally to a variety of subjects of investigation. The present pictures have great value, and many of them great—indeed astonishing—beauty (*e.g.* the wrestling boys). They should be purchased by those who can afford them for the purpose of bearing a share in the expense of so important an experiment as that set agoing by the University of Philadelphia. But we should like to see the batteries turned on again, and a number of new subjects investigated. Terrestrial locomotion has been gradually developed through an amphibious transition from aquatic locomotion. The movements of fishes, of tadpoles, salamanders, turtles, and crocodiles should be included in the scope of any study of vertebrate limb-play. But even more necessary is it that in future the scientific method, of theory, test hypothesis, and experiment, should be followed in the application of the photographic batteries, so that each set of photographs may definitely prove some particular point or points in the orderly development of a general doctrine.

For my own part, I should greatly like to apply Mr. Muybridge's cameras, or a similar set of batteries, to the investigation of a phenomenon more puzzling even than that of "the galloping horse." I allude to the problem of "the running centipede." I have a series of drawings made from large West Indian specimens which I kept alive for some time in my laboratory at University College. At the same time I made drawings and recorded as well as I could the movements of the legs of *Peripatus capensis*, which was also (through Mr. Sedgwick's kindness) living in my laboratory. I am anxious to compare with these movements the rapid rhythmical actions of the parapodia of such Chætopods as Phyllodoce and Nephthys on the one hand, and the curious "gait" of the Hexapod insects, of which Prof. Lloyd Morgan has already written a few words in NATURE. Passing on to scorpions and spiders, and then to shrimps, lobsters, and crabs, we should eventually possess the outlines of an investigation of Arthropod locomotion. There is no doubt that the Muybridge battery would be the one effective means of study in the case of the centipede and marine worms, although in some cases a good deal may be done by intent observation and hand-drawn records. The difficulty of this investigation, and the disastrous results in the way of perplexity which follow from too close an application to it *without* the aid of Mr. Muybridge, is set forth in certain lines, the authorship of which is unknown to me or to the friend who kindly sent them to me on hearing that I was studying the limb-play of centipedes. May I be pardoned for quoting them, and associating in this way fancy with fact, whilst expressing the hope that Mr. Muybridge will take steps to prevent any such catastrophe in the future as these lines record!

> A centipede was happy—quite!
> Until a toad in fun
> Said, "Pray which leg moves after which?"
> This raised her doubts to such a pitch,
> She fell exhausted in the ditch,
> Not knowing how to run.

E. RAY LANKESTER.

ON THE DETERMINATION OF MASSES IN ASTRONOMY.

IN the *Annuaire du Bureau des Longitudes* for 1889 occurs an interesting article by M. Tisserand on the methods employed in the measurement of the masses of the heavenly bodies. The writer begins with an explanation of the elementary principles leading to the law of Newton that *all bodies attract one another with a force which is proportional to their masses and inversely as the square of the distance between them.* He proves, in a popular manner, that this force is equal to the product of mass into acceleration; and therefore, speaking theoretically, to compare the masses of two bodies it is only necessary to apply directly to each of them the same force and to measure the acceleration produced; or, if a body be placed in succession at the same distance from the sun and the earth it will be attracted towards each with a force which is proportional to their masses. Hence, since the space traversed by a body is directly proportional to the acceleration, if during the first second the body fell 330 metres towards the sun, and 1 millimetre towards the earth, it would be obvious that the sun had a mass 330,000 times greater than the earth. Similarly, by applying the law of inverse squares, the relative masses of the sun and earth might be found when the distance of the body from each was not the same. We find that the earth falls towards the sun 10·60 metres in a minute, and that our moon falls towards the earth 4·90 metres in the same time. But the earth is 386 times nearer the moon than it is to the sun, so correcting for difference of distance we get $\frac{4\cdot9}{(386)^2}$ = 0·0000328 metre as the fall of the moon towards the earth in a minute. Therefore the sun's mass is to the earth's mass as 10·6 is to 0·0000328—that is, 1/323,000. This method is, however, dependent on our knowledge of the distance of the sun and moon. The same calculation may be employed, without modification, to find the mass of a planet having a satellite. Kepler's third law is used for expressing the mass m of a planet in terms of the sun's mass M. The formula being:—

$$\frac{m}{M} = \left(\frac{a'}{a}\right)^3 \left(\frac{T}{T'}\right)^2,$$

where a is the semi-major axis of the planet's orbit and T the time of revolution round the sun; a' and T' representing similar terms for the satellite.

In the case of Jupiter, observations of the four satellites may be made and the mean result taken. A recent determination by M. Schur gives the value 1/1047·232 as compared with the sun.

Saturn's mass has been obtained from observations of its two largest satellites, Titan and Japetus. Bessel's researches made it 1/3502, whilst Struve found a value 1/3498. This gives roughly the fraction 1/3500 as the planet's mass.

Newcomb deduced, from observations of the four satellites of Uranus, a mass 1/22,600, and by observations of Neptune's one satellite found a value 1/19,380 as the planet's mass.

Before the discovery of the Martian satellites by Hall, the mass of the planet was a matter of great uncertainty. The discoverer's observations of the satellites led him to assign 1/3,100,000 as the mass of Mars, a result probably not far from the truth

The Masses of Planets without Satellites.

For the determination of the masses of Mercury and Venus a different and much less exact method of procedure is used. If the masses of Venus and the earth were known, the perturbations they would give to the motion of Mercury could be easily calculated. Let the orbit be calculated which Mercury would have if it existed alone with the sun, and then let its true path be found. By comparing the two paths the disturbing effect of Venus and the earth may be also found. In a similar manner the calculated and true paths of Venus may be compared; the disturbing masses being Mercury and the earth. In this way a series of equations is obtained from which the masses of Mercury and Venus may be isolated. The result in the case of Mercury is 1/5,000,000.

The Mass of Jupiter.

M. Tisserand gives a full discussion of the methods of determining Jupiter's mass, which, being so considerable, shows itself in its effects upon many bodies of our system.

Beginning with comets, he quotes the comet of Lexell as a typical case. In 1769 this comet approached very near to Jupiter, and by the planet's action was brought within our range of vision and given a period of $5\frac{2}{3}$ years. Its return in 1776 could not be observed, and before another revolution could be completed, viz. in 1779, the comet was shown by Lexell to have again approached very near to Jupiter, nearer than the fourth satellite. The probable result was that the elliptic orbit was transformed into a parabolic one by the predominance of the planet's attraction over that of the sun, and the comet left our system, never to return.

From observations of the perturbations of Winnecke's comet, M. de Haertl found Jupiter's mass to be 1/1047·175, whilst Faye's comet gave the value 1/1047·788.

Some of the asteroids approach very near to Jupiter, amongst these are (24) Themis, (49) Pales, and (153) Hilda, and from observations of the motion of Themis the planet's mass has been found 1/1047·538. Estimations have also been made by observations of the perturbations of Saturn, but, since the necessary series should cover a cycle of 900 years, and only 120 years are available, the method is not yet very exact. This accounts for the anomalous result 1/1070·5 found by Bouvard in 1821.

It is also mentioned that Airy, from 1832 to 1836, observed the motion of the fourth satellite and found for Jupiter a mass 1/1047·64, whilst Bessel in 1841 found 1/1047·905.

The following are the masses of the planets given by M. Tisserand, with the earth as unit:—

Mercury	$\frac{1}{15}$	Jupiter	310
Venus	$\frac{4}{5}$	Saturn	93
The Earth ...	1	Uranus	14
Mars	$\frac{1}{10}$	Neptune	17

Cavendish's method for determining the mean density of the earth is next explained, and it is shown that, knowing the relative masses of the planets as given in the above table, we may express their weights in pounds.

Determination of the Masses of Asteroids.

Some pages are devoted to a discussion of these small bodies. It has been found that the effect of each asteroid is to give a motion to the line of apsides of Mars's orbit. The sum of these effects is the same as would be produced by taking a mean orbit of all the asteroids and distributing them uniformly in it. Leverrier made a calculation on the assumption that the total mass of the asteroids was equal to that of the earth, and he found that, if they had a mass only equal to one-fourth that of the earth, Mars would be disturbed by an amount clearly perceptible to us. M. Swedstrup has found the assumption too high, and has calculated that the sum of all the asteroids known up to August 1880 is only about 1/4000 of the earth's mass, or about 1/50 that of the moon. Three comparatively large asteroids have had their diameters measured. Sir W. Herschel found the apparent diameter of Ceres and Pallas to be 0"·35 and 0"·24 respectively; the equivalent in kilometres being 250 and 170 For Vesta, Mädler found an apparent diameter 0"·65, or 470 kilometres. If these bodies be supposed to have the same density as the earth, their proportional masses will be found—Ceres, 1/130,000; Pallas, 1/420,000; Vesta, 1/20,000. By photometric means, the diameters of these asteroids have been determined by Prof. Pickering, and also of some much smaller, such as Eve, with a diameter of 23 kilometres, and Menippe, whose diameter is only 20 kilometres, being no larger than the meteorites met by the earth daily.

Determination of the Masses of Satellites.

The method of determining the mass of our satellite based upon the fact that it is the common centre of gravity of the earth and moon, and not the earth itself, which moves in an elliptic orbit round the sun, is fully explained by the writer. By means of it, the mass of the moon has been found 1/81 that of the earth. Observations of the proportion of lunar to solar precession, as well as lunar and solar tides, also furnish a means of determining the moon's mass.

Masses of Jupiter's Satellites.

These bodies, so proportionally small, the greatest being only 1/10,000 of the planet's mass, cannot have their masses accurately determined by the measurement of the angle subtended by the line joining the planet to the common centre of gravity; for, since the line joining the planet to its satellite is divided into parts inversely proportional to their masses in order to find this point, the line in question is very small. Hence the best method of determining the measures of the satellites in this case is, according to M. Tisserand, by measurement of the disturbances upon each other. This method was propounded and worked out by Laplace with the following results, in terms of Jupiter's mass:—

1st satellite ...	1/59,000	3rd satellite ...	1/11,000
2nd ,, ...	1/43,000	4th ,, ...	1/23,000

This proportion would give the third satellite a mass about double that of our moon.

The Satellites of Saturn.

Titan, as its name suggests, is the largest of the family, and consequently exercises a considerable influence over the others. Prof. Hall found that under its action the major axis of Hyperion's orbit made a complete revolution in about eighteen years. Newcomb, Tisserand, Stone, and Hill have each investigated the matter, but it is mainly due to the two latter observers that Titan's mass has been found 1/4700 that of Saturn. Prof. Pickering has compared the diameters of the other satellites with that of Titan by photometric means, and, if

they all have the same density, the following numbers represent their masses, Saturn's mass being unity :—

Mimas ...	... 1/500,000	Rhea ...	... 1/32,000
Enceladus	... 1/270,000	Hyperion	... 1/1,800,000
Tethys ...	... 1/75,000	Japetus	... 1/110,000
Dione ...	... 1/85,000		

The mass of Saturn's rings has been found 1/620 that of the planet by observations of the rotational movement which it imparts to the major axes or line of apsides of the satellites.

The masses of the satellites of Uranus and Neptune are not known to any degree of accuracy. The two satellites of Mars have had their masses deduced from photometric measures, but they are so small—about 10 kilometres in diameter, being no larger than the smallest known asteroids—that the numbers found cannot be very exact.

Masses of some Stars.

M. Tisserand rightly gives a dissertation, full and clear withal, of this subject. Sir William Herschel was the discoverer of the relative motions of binary stars in 1802. The obvious conclusion from such a discovery was that the laws of gravitation were universal. Truly, it was not logical to make such an assumption, and some objections have been raised, but the *onus probandi* rests with those who doubt it. In considering the motions of the components of a binary star system, it must be remembered that they revolve round a common centre of gravity. It is usual, however, to consider the principal stars as fixed, but augmented by the mass of its satellite, the latter having an orbit which is the mean of the two. Knowing the fall of the satellite to its primary in one second, we may calculate what it would be if at the same distance from it that the earth is from the sun. But we know by how much the satellite would fall towards the sun, since it would fall as the earth. Hence the consideration of the two falls will give the sum of the masses of the stars in terms of the sun's mass.

The following is the formula employed :—

$$\frac{m + m'}{M} = \left(\frac{a}{p}\right)^3 : T^2 ;$$

m and m' are the masses of the two stars ; M that of the sun ; a is the angle, expressed in seconds, which is subtended at the earth by the semi-major axis of the satellites orbit ; p is the "annual parallax" of the binary group expressed in seconds ; whilst T is the time in years of one revolution of the satellite. These are the numbers that have been obtained for four groups, the distances of which from the earth are known :—

Star.		Parallax.		Magnitude.		Sum of Masses.
α Centauri	...	0″·80	...	1	...	1·8
η Cassiopeiæ	...	0″·15	...	4	...	8·3
70 ρ Ophiuchi	...	0″·17	...	4·5	...	2·5
σ² Eradini	...	0″·22	...	4·5	...	1·0

Sirius and its Companion.

The article concludes with a complete history of the work which suggested the existence of a companion to Sirius. Bessel had determined the proper motion of thirty-six stars by observations of their right ascensions and comparing with Bradley's, but he found that in the case of Sirius the hypothesis of a uniform variation was irreconcilable with them, and suggested that the irregularities might be produced by the action of some obscure body. As a proof that obscure bodies exist in the heavens, the case of Tycho Brahé's Nova is quoted, this being a star which suddenly appeared in Cassiopeia in 1572, and then gradually disappeared without change of place. After Bessel's death Peters found that it was possible to account for the irregularities by the supposition that Sirius described an orbit in fifty years whose eccentricity was about 0·8. Safford, in 1861, from a discussion of the declinations of Sirius, came to the same conclusion as Peters ; whilst Auwers, in 1862, after investigating about 7000 right ascensions and 4000 declinations, found the time of revolution to be forty-nine years, and the eccentricity 0·601. At the same time as Auwers was engaged with his calculations, Alvan Clark discovered a small star only about 10″ from Sirius, which appeared to be the companion. Future considerations supported the surmise, and proved that this body was precisely what was required to account for the orbit of Sirius round the common centre of gravity.

If Gill's measure of the parallax of Sirius be taken as correct, viz. 0″·38, the sum of the masses of the two stars is equal to 4·4 that of the sun. Sirius has about twice the mass of its companion, and they are separated by a distance a little more than twice the distance of Uranus from the sun.

From a discussion of similar little irregularities in the proper motion of η Cassiopeiæ, Struve found its mass to be 6·6 compared with the sun, whilst its companion was 1·7 times as great.

A reflection on the inability of astronomers before Copernicus to make such measurements as those preceding, concludes this retrospect.

R. A. GREGORY.

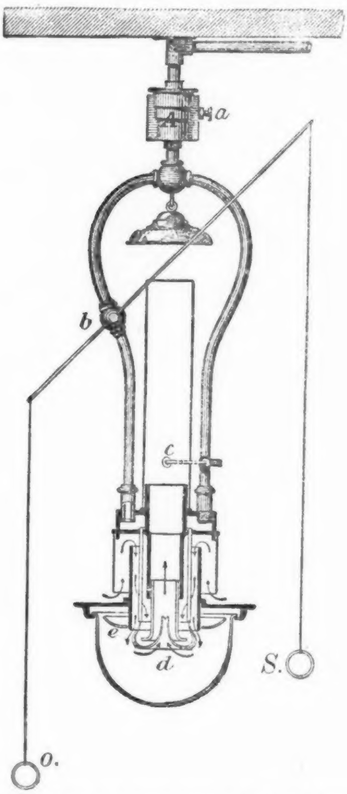
A NEW FORM OF REGENERATIVE GAS-LAMP.

FROM the time when Mr. Frederick Siemens first introduced regenerative gas-burners, now ten years ago, down to the present day, this method of burning gas for illuminating purposes has been adopted all over the world, and has come to the assistance of the gas companies by illustrating the fact that, with proper appliances, gas can produce the same brilliant effects as are ordinarily produced by means of electricity, at much less expense both as regards first cost and working. We would explain that in regenerative lamps the heat which is usually wasted in ordinary burners is to a great extent returned to the flame. The manner in which this result is brought about is by intercepting, by means of a regenerator, the heat passing away with the products of combustion, and applying the heat thus saved to raise the temperature of the air which feeds the flame, thus increasing the temperature of the latter, and its illuminating power ; for it may be admitted that the higher the temperature of a body rendered incandescent by heat, the greater is the proportion of light rays emitted out of the total amount of energy radiated. This being the case, the amount of heat carried from such a source of illumination to the surrounding atmosphere by conduction and convection must be less than in the case of a burner consuming the same quantity of gas burning at a lower temperature, which circumstance, combined with the well-known economy resulting from the use of these burners, accounts to a great extent for the popularity which regenerative lamps have attained.

Mr. Frederick Siemens has lately introduced a new form of regenerative gas-lamp, which we understand is highly efficient, and is in consequence being largely adopted ; its construction is shown in the accompanying diagram. It is known as the Siemens inverted type, and is produced in various ornamental designs, which have been much admired. After passing through the governor A, and the tap b, the gas enters an annular casing ; in the lower portion of this, a number of small tubes are fixed, forming the burner, from which tubes the gas passes out in separate streams. By this means, combustion of a very perfect character takes place, as the air is directed round each separate stream of gas, and thus enabled to combine most intimately with it. Within the circle of small tubes is a trumpet-shaped porcelain tube, d, and around the outside and inside of this the gas burns downwards and slightly upwards, as indicated by arrows,

thus producing a steady powerful flame of beautiful appearance. This porcelain tube forms the lower portion of the chimney, around which is placed the regenerator. The products of combustion, in passing away, heat the regenerator by conduction, through the metal of the same; and the air, passing upwards and downwards between its metallic surfaces, as also indicated by arrows in the diagram, carries the heat back to the flame. The lamp is closed below by a glass globe, which, however, need not be removed for lighting, as a flash-light is provided for that purpose.

These lamps are made of different sizes, with a consumption varying from 10 to 40 cubic feet of gas per hour; with London gas they give a light of from ten to twelve candles per cubic foot consumed per hour, which is from four to five times as much as is obtained with ordinary burners. It would have been easy to arrange the lamp we have just described so as to produce a much higher result than that given above; but, to produce this effect, the air supplying the burner would have to be passed through small channels, which would be liable to be partly closed up by oxidation, and thus, by reducing the air-supply, cause the lamp to smoke, whereas the Siemens lamp has been specially designed to provide against this unpleasantness, to which regenerative gas-lamps are more or less liable.



HEINRICH GUSTAV REICHENBACH.

On the 6th inst., there died at Hamburg, in the sixty-seventh year of his age, a botanist long and familiarly known to his English colleagues, and one whose name will be preserved in the annals of botany.

Heinrich Gustav Reichenbach had been Professor of Botany and Director of the Botanic Garden at Hamburg since 1862. He was born in Leipzig, his father having been also a well-known botanist and Professor in Dresden from 1820 till his death in 1879. Much of the younger Reichenbach's work was done in association with his father, with whom he co-operated in the production of the later volumes of the carefully elaborated *Icones Floræ Germanicæ et Helveticæ*. But work of this character, carefully and critically executed though it was, was cast into the shade by the magnitude of his labours among the Orchidaceæ. Reichenbach the younger devoted more than forty years of his life, almost (though, as we have seen, not quite) exclusively to the study of orchids.

At the commencement of his career, Lindley was still in the plenitude of his powers, but when, some quarter of a century since, the great English botanist failed in health, and subsequently died, there was no one to question the supremacy of Reichenbach so far as orchids were concerned.

From that time to the present the Hamburg Professor has reigned with undisputed sway. His reign corresponds in its progress with the development of that passion for the cultivation of orchids which has attained such large proportions in this country. This is a fashion which at present shows no sign of waning here, whilst it is spreading widely in other countries. It has proved of signal service to orchidology in its systematic aspect, and to a less degree to morphology and biology, as witnesses, to cite only one illustration, the work of Darwin on the "Fertilization of Orchids." A hundred years ago about three hundred species were catalogued in the later editions of Linnæus's "Species Plantarum," and those three hundred were very imperfectly known or illustrated. About sixty years have elapsed since Lindley began his first systematic enumeration of the genera and species, a work in which he was at first greatly aided by the previous labours of Brown and by the splendid drawings of Bauer. In 1840, at the conclusion of the "Genera and Species," Lindley mentions that the total number of species included in that work amounted to 1980, of which the author himself had analyzed three-fourths. Later estimates in the "Vegetable Kingdom" bring the numbers up to 394 genera and 3000 species. Bentham, in 1883, calculated the known species as between 4500 and 5000; while Pfitzer, the most recent census-maker, gives the extreme number of species as 10,000. Granting that this latter figure is excessive, it at least suffices to illustrate the enormous increase in our knowledge of orchids. This advance has been, as we have said, chiefly due to the orchidomania which originated as a consequence of the exhibition of a few remarkable forms at the early meetings of the Horticultural Society, and which has been growing ever since. We never heard of any material good arising from the tulipomania; but the passion for orchids, involving, as it has done, the exploration of the countries where they grow, and the collection and transmission of countless thousands of specimens, live and dead, not only of orchids but of plants of other orders also, has most undoubtedly been of great service to botany, and it has served also to illustrate the great, but often unappreciated, value of gardens as instruments of scientific research. Dried specimens of orchids afford a sorry spectacle at best, and the characters upon which the distinction of genera and species depend are readily obliterated or lost in the drying process. But in gardens the material is often ample, and in the best condition for examination.

Reichenbach, as we have seen, was able to avail himself to a much larger extent than any of his predecessors of the facilities offered by gardens. He became the acknowledged referee on all questions of nomenclature, and to him were constantly submitted fresh specimens for examination. Of late years, also, hybridization has been practised to a large extent among orchids, and the resultant hybrids found their way to Hamburg, there to be

compared with the parental forms from which they had emanated. The result of this correspondence with orchid-growers of all classes in all countries, as well as with collectors and botanists, was that the Hamburg Professor became the depositary of the greatest amount of orchid-lore yet accumulated, and the possessor of the largest stores of materials relating to the order. Unhappily his synthetic faculty was by no means so strong as his acquisitive tendencies were great and as his analytical powers were developed; so that much is left for his successors to accomplish in collating and expounding his work. In no place in the world can this be done so readily as at Kew, so that on all accounts it is earnestly to be hoped that the late Professor's herbarium and notes may find their way to that establishment, where Lindley's collections are already enshrined.

Reichenbach was almost exclusively a systematist. He had little to say on morphological questions, and less on the biological points which lend such great interest to the study of the order. Speculations were made the subject of sarcasm by him, and to the last it may be doubted whether he had any great amount of sympathy with those researches which have furnished the clue to the explanation of the extraordinary and highly diversified structure of orchid-flowers, and illustrated alike its genetic and its physiological significance. Nevertheless, as in his lifetime he was constantly and disinterestedly at the service alike of his brother naturalists and of the orchid-growing community, shrinking from no labour or trouble where an orchid was concerned, so in that future reconstruction of the order on morphological and physiological principles which is inevitable, the botanist, be he who he may, will find himself as much indebted to the labours of Reichenbach, as unable to proceed without constant reference to them, as are the students of the present day. His title to our gratitude is indefeasible; it will be even more so to our successors.

NOTES.

THE Croonian Lecture, "Les Inoculations Préventives," will be delivered at the Royal Society to-day, by Dr. Roux, of the Pasteur Institute, Paris.

THE ship *Hvidjörnen* arrived at Copenhagen on May 21 from Greenland, having on board Dr. Fridtjof Nansen and his companions, who succeeded in crossing Greenland from east to west on snow shoes. The members of the expedition received an enthusiastic welcome from a large crowd.

THE anniversary meeting of the Royal Geographical Society, for the election of President, Council, &c., will be held in the hall of the University of London, Burlington Gardens, on Monday, May 27, at 2.30 p.m., General R. Strachey, F.R.S., C.S.I., President, in the chair. After the presentation of the Royal medals for the encouragement of geographical science and discovery, the annual address on the progress of geography during the year will be delivered by the President.

AN International Congress of Chronometry will be opened at the National Observatory, Paris, on September 7. An influential organizing Committee has been formed, of which Vice-Admiral de Fauque de Jonquières has accepted the presidency. Those who wish to become members should communicate with the secretary, M. E. Caspari.

CONGREGATION has approved of the nomination of Dr. William Huggins, F.R.S., as a visitor of the Oxford University Observatory, in place of the late Dr. Warren de la Rue.

ACCORDING to the Rome Correspondent of the *Daily News*, the Pope has decreed, owing to the wishes expressed by Padre Denza more than a year ago, that the works for the Astronomical Observatory, to be erected in the Vatican, are to be begun at once. The site selected is the tower over the rooms occupied by the Master of the Sacred College, it being the most elevated building of the Vatican Palace. The cost is estimated at a million of francs.

MR. W. P. JOHNSTON, Government Electrician, Calcutta, died on April 23, at Darjeeling. According to *Allen's Indian Mail*, Mr. Johnston had served for over twenty years in the Indian Telegraphs, and had specially distinguished himself in the scientific branch of the Department, his researches in connection with duplex telegraphy, the working of river cables and long stretches of land lines, having been unusually productive of good results. He was also one of the first to improve the telephone after its introduction into India.

IT is reported in the Chinese Press that the Marquis Tsêng, so well known in Europe as the Ambassador of China to this country, has been appointed to the control of the Foreign Science College in Pekin.

PROF. MILNE, of the University of Tokio, whose work in connection with the investigation of earthquake phenomena is well known to all readers of this journal, is in England for a short time on leave of absence.

DR. JOHN GIBSON, who has for some time been engaged in superintending the physical work of the Fishery Board for Scotland, has recently completed a series of investigations which are likely to throw considerable light on the problems connected with ocean currents. The detailed results will appear in the next Annual Report of the Fishery Board; but from a preliminary note communicated to the Royal Society of Edinburgh it appears that two chemically distinct kinds of sea water are present in the North Sea. The difference between these two waters is rendered perfectly distinct by sufficiently accurate determinations of the relation between chlorine and density, and is not due to river water flowing into the North Sea. Water in which the relative proportion of chlorine is high reaches the North Sea from the surface of the Atlantic, round the north of Scotland and also through the English Channel, while water in which the relative proportion of chlorine is low flows into the North Sea from the north, and has been found on the surface as far north as 79° N. lat. The determinations of chlorine and density in the samples of ocean water collected during the *Challenger* Expedition, as published in the *Challenger* Reports, seem to show that similar differences of composition exist in ocean waters. To judge from these determinations, the mass of ocean water, especially in southern latitudes, approximates in chemical composition to that flowing as above mentioned into the North Sea from the surface of the Atlantic. The water in which the relative proportion of chlorine is less appears to have been met with chiefly to the north of the equator and to the south-west of the principal outlets from the Arctic Ocean. This, as well as its chemical composition, seems to point to an Arctic origin.

A SEVERE earthquake occurred at Plevlje, in Bosnia, at 3.43 a.m., on May 8. It lasted three seconds, the direction of the shocks being from west to east.

SEVERAL shocks of earthquake occurred on April 26 in Schwyz, and at Schaffhausen and Wilchingen.

ON May 20 a waterspout burst over the district of Crimmitzschau, in Saxony. Two persons were drowned at the town of that name, and a third at the neighbouring village of Lauterbach.

THE British Consul at San José, in Costa Rica, in his latest report says that a Meteorological Institute has been established at San José, and several useful observations have been taken, especially of recent earthquakes. He adds that the year 1888 did not have a very propitious closing, for just two days

before the end of the year, the capital and surrounding districts were visited with several severe shocks of earthquake. The first shock took place on December 29 at 8 p.m. This was followed by another at 11 p.m., and on Sunday, December 30, at 4.21 a.m., by the most severe of all, lasting 25 seconds, and of such force as to cause considerable damage to the principal buildings in San José, and to nearly all the churches, besides private houses, few of which escaped damage. The morning was pitch dark, and hundreds of people, in all kinds of costumes, hurried into the Central Park looking for their friends, not knowing what might happen or whether any portion of their houses would be left to them. Several houses have been condemned by the authorities, and have had to be pulled down, whilst energetic measures are being taken to repair the damage done to the principal buildings, and the Government have erected temporary shelters for the poor who have been rendered homeless. The total damage is estimated at half a million sterling.

THE half-yearly meeting of the Council of the Italian Meteorological Society was held on April 28. Padre Denza referred to the activity of the Society during the previous six months, during which time several observing stations had been added in Italy and at Malta and Punta Arenas (South America); and to the working of the hygienic stations established at Florence and several other important cities. He also referred to the various Conferences which are being held in accordance with the decisions of the general meeting at Venice last year, for the purpose of popularizing meteorological science in Italy. Special investigations are being carried out with the view of determining the amount of carbonic acid gas in the air, and with regard to the system of the winds in the South Atlantic. The questions of sunshine and phenological observations were also discussed, and the importance of issuing general instructions for these subjects, and for the regular geodynamical observations at the Society's stations.

AT the meeting of the Scientific Committee of the Royal Horticultural Society on May 14, Mr. Wilson made some remarks on the question of the protection of fruit-trees against winter moths. He observed that the plan recommended in the *Agricultural Gazette* of October 15, 1888, of making a ring of cart grease and Stockholm tar round the bases of fruit-trees, though very effectual in catching large quantities of wingless females, had not prevented them from attacking the trees altogether, as the leaves on certain trees thus treated (as described at the Scientific Committee on January 15, 1889) were all going at the present date. At the same meeting Dr. Masters exhibited several photographs of plants from Madeira, including one of *Phytolacca dioica* as a large tree with a massive base of confluent roots, the usual form of this plant in Europe being a herb.

AT the last meeting of the Chemical Society of Göttingen, Dr. Buchka announced the results of his investigations upon the composition of bromide of sulphur. Balard long ago showed that sulphur readily dissolves in bromine with formation of a ruby-red liquid; this liquid, as more recently shown by Mr. Pattison Muir, may be freed from excess of bromine by means of a current of dry carbon dioxide. On attempting, however, to subject it to distillation, it is found to boil at about 200° C., but with decomposition. Indeed it is possible, by repeated distillation, to completely dissociate it into sulphur and bromine. Hence it has never hitherto been possible to analyze a sample of the redistilled liquid, and so there has been a certain amount of doubt as to its composition. Most of the analyses hitherto published have pointed to the formula S_2Br_2, but Guyot ascribes to it the formula SBr_2. Hence Dr. Buchka has attempted the distillation of the crude product under diminished pressure, and finds that the experiment entirely succeeds at the low pressure of 20 mm. of mercury, the red liquid passing over without the least sign of decomposition at a temperature of 111°-113°. Analyses of this redistilled liquid confirm the formula S_2Br_2. Hence bromide of sulphur resembles the monochloride, S_2Cl_2, the most stable of all the chlorides of sulphur: it differs from the chloride, however, in being more unstable, and only volatilizable without decomposition at a pressure not much exceeding 20 mm. of mercury.

FORMALDEHYDE, CH_2O or $H.COH$, the first member of the important series of aldehydes, has been synthesized by Prof. Jahn, of Cronstadt, Hungary, in a most instructive manner. During the course of Dr. Jahn's well-known researches upon the volumetric estimation of hydrogen by means of palladium, it was noticed that the presence of carbon monoxide always considerably disturbed the occlusion of the hydrogen by the palladium. As there was a possibility that some of the hydrogen had bodily united with the carbonic oxide with formation of formaldehyde, it was determined to repeat the experiment upon a larger scale and in a more suitable form of apparatus. A mixture of carbon monoxide and hydrogen was therefore led over a layer of spongy palladium, and the products passed through a series of bulbs containing water. On detaching the bulbs the odour of aldehyde was readily perceived, and the contents at once reduced an ammoniacal silver nitrate solution with formation of the silver mirror characteristic of aldehydes. Hence it was quite evident that the carbon monoxide and hydrogen had partially united in the pores of the palladium with production of formaldehyde. Two litres of the mixed gases were found quite sufficient to give a good silver mirror. This reaction is all the more interesting in view of Dr. Loew's recent synthesis of formose, $C_6H_{12}O_6$, an artificial member of the glucoses, by condensation of formaldehyde with calcium hydroxide; for as carbon monoxide is readily prepared by passing oxygen over excess of heated carbon, it may be said that glucose has been built up directly from its elements—carbon, hydrogen, and oxygen.

THE officials of the Australian Museum, Sydney, are now engaged in working at the Percoid Fishes, and the trustees announce that they will be glad to make exchanges in this group with the authorities of other museums.

THE Paris Correspondent of the *Daily News* says the Zoological Society of France has warned the French Government that a great ornithological calamity is impending. The Department of the Bouches du Rhône has hitherto been one of the chief landing-places for swallows coming from Africa. Engines for killing them, formed of wires connected with electrical batteries, have been laid in hundreds along the coast. When fatigued by their over-sea flight, the birds perch on the wires and are struck dead. The bodies are then prepared for the milliner, and crates containing thousands of them are sent on to Paris. This has been going on for some years, and it has been noticed this spring that swallows have not landed on the low-lying coast, but have gone farther west or east, and that they go in larger numbers than formerly to other parts of Europe. There are places, says the Zoological Society in its petition, where they used to be very numerous, but which they have now deserted, although there has been no falling-off in the gnats and other flying insects on which they live.

MISS E. C. JELLY, F.R.M.S., proposes to issue shortly a catalogue of the published species of recent Polyzoa, with a full synonymy. The main lines followed are those of Hincks and Waters. Only a limited number of copies will be printed, and application for them must be made to the authoress.

THE State University of Iowa has begun to issue what promises to be an excellent series of Bulletins from its laboratories of natural history. No systematic biological survey of the State has yet been attempted, and the editors of the new

Bulletin do not suppose that it will be in their power to provide such a survey. They propose, however, to bring before their readers some idea of the natural history of Iowa, and of the manner in which it may be studied; hoping in this way to stimulate an interest in such things sufficient to lead to greater results in the future.

AN interesting note, by Mr. Arthur A. Rambaut, on some Japanese clocks lately purchased for the Dublin Science and Art Museum, has been reprinted from the Proceedings of the Royal Dublin Society. These clocks, though differing in other respects, agree in this particular, that the time is recorded, not by a hand rotating about an axis, but by a pointer attached to the weight, which projects through a slit in the front of the clock-case. This pointer travels down a scale attached to the front of the clock, and thus points out the hour. Mr. Rambaut has consulted several persons who have been resident for some time in Japan, but none of them has ever seen clocks of like construction in actual use. A young Japanese gentleman to whom the specimens have been shown, says that he has heard of such clocks being used in rural parts of Japan about twenty or thirty years ago, but that they have been almost completely superseded by clocks made on the European plan.

THE fact of intermittence in the intensity of some sensations is known to physiologists. Thus, the tick of a watch withdrawn gradually from the ear begins to be heard, by turns, distinctly and indistinctly, then times of silence alternate with the sound. M. Couetoux, in the *Revue Scientifique*, calls attention to an analogous experience he has had in the case of vision. Looking at a distant windmill, with four vanes, he could not make up his mind whether it was in slow motion (like a nearer one); for, of the three vanes projected against the sky, he saw now one, now another; but the intermittent degradation of the sensorial impression prevented his observing two successive positions. These sensorial fluctuations seem to deserve careful study.

AT a recent meeting of the Manchester Section of Chemical Industry, Mr. William Thompson read a paper on the heat-producing powers of twelve samples of coal, determined by burning in oxygen (in the apparatus devised by him), compared with their theoretical values as calculated from their chemical composition. The coal which he found to give the highest results as regards heat-producing was anthracite, which gave 8340 Centigrade units of heat. Next came Pendleton coal, with 7736 units; then Wigan coal, 7552; and the lowest of the twelve came from near Atherton, with 6448 units. The results obtained by experiment were higher in two coals than the calculated results obtained by determining by heat units given by the combustion of the carbon, hydrogen, and sulphur found by analysis, but deducting the hydrogen, which appears always to be in combination with the oxygen present, so that its hydrogen does not produce heat on burning. In two coals the heat found by calculation and that found by experiment were the same, and in seven coals the heat found by calculation was greater than that found by experiment. A short discussion followed the reading of the paper.

THE additions to the Zoological Society's Gardens during the past week include a Rough Fox (*Canis rudis* ♂) from Demerara, presented by Mr. James Coombe; a Derbian Wallaby (*Halmaturus derbianus* ♂) from Australia, presented by Mr. Buckland, s.s. *Britannia*; two Great Eagle Owls (*Bubo maximus*), European, presented by the Executors of the late Mr. W. J. Cookson; two Red-legged Partridges (*Caccabis rufa*) from the Canary Islands, presented by Captain Augustus Kent, s.s. *Fez*; six Barbary Turtle Doves (*Turtur risorius*) from North Africa, presented by Major T. Erskine Baylis, F.Z.S.; a Black-bellied Sand Grouse (*Pterocles arenarius* ♂) from India, presented by Mrs. Ayrton Pullan; a —— Falcon (*Falco* sp. inc.) from Australia, presented by Baron F. von Mueller, C.M.Z.S.; a Tuberculated Iguana (*Iguana tuberculata*) from Spanish Honduras, presented by Mr. J. B. Johnson, s.s. *Antilles*; a Grey-breasted Parrakeet (*Bolborhynchus monachus*) from Monte Video, presented by Mrs. Macnab; ten Common Vipers (*Vipera berus*) from Surrey, presented by Mr. C. F. McNiven; two Common Vipers (*Vipera berus*) from Gloucestershire, presented by Mr. Barry Burge; a Chimpanzee (*Anthropopithecus troglodytes* ♂) from West Africa, two Cormorants (*Phalacrocorax carbo*), British, deposited; a Mountain Ka-ka (*Nestor notabilis*) from New Zealand, a Green-headed Tanager (*Calliste tricolor*) from South-East Brazil, purchased; five North African Jackals (*Canis anthus*), a Japanese Deer (*Cervus sika* ♀) a Collared Fruit Bat (*Cynonycteris collaris*), a Great Kangaroo (*Macropus giganteus* ♂), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *MAY* 26—*JUNE* 1.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 26

Sun rises, 3h. 56m.; souths, 11h. 56m. 48·8s.; daily increase of southing, 6·5s.; sets, 19h. 58m.: right asc. on meridian, 4h. 13·8m.; decl. 21° 13′ N. Sidereal Time at Sunset, 12h. 16m.

Moon (New on May 29, 17h.) rises, 3h. 2m.; souths, 9h. 36m.; sets, 16h. 24m.: right asc. on meridian, 1h. 52·8m.; decl. 6° 16′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	5 4	13 34	22 4	5 51·4	25 12 N.
Venus.....	2 41	9 47	16 53	2 3·9	11 55 N.
Mars......	4 12	12 23	20 34	4 39·9	22 41 N.
Jupiter....	22 18*	2 14	6 10	18 29·6	23 3 S.
Saturn....	9 16	16 53	0 30*	9 11·1	17 27 N.
Uranus...	15 20	20 50	2 20*	13 8·3	6 34 S.
Neptune..	3 58	11 45	19 32	4 1·5	19 2 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

May.	h.	
26	16	Venus in conjunction with and 4° 30′ north of the Moon.
31	16	Mercury in conjunction with and 1° 53′ north of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m	
U Cephei	0 52·5	81 17 N.	May 26,	0 30	*m*
			,, 31,	0 9	*m*
R Crateris	10 55·1	17 44 S.	,, 27,		*M*
W Virginis	13 20·3	2 48 S.	June 1,	1 0	*M*
δ Libræ	14 55·1	8 5 S.	May 27,	22 33	*m*
U Coronæ	15 13·7	32 3 N.	June 1,	21 0	*m*
U Ophiuchi	17 10·9	1 20 N.	May 27,	1 42	*m*
			and at intervals of	20 8	
β Lyræ	18 46·0	33 14 N.	May 27,	20 30	*M*
			,, 31,	2 0	*m*
U Aquilæ	19 23·4	7 16 S.	June 1,	3 0	*M*
S Vulpeculæ	19 43·8	27 1 N.	May 28,		*M*
S Sagittæ	19 51·0	16 20 N.	,, 29,	2 0	*m*
			June 1,	2 0	*M*
δ Cephei	22 25·1	57 51 N.	May 31,	23 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
	290°	60° N.	May 30. Short, slow.
From Vulpecula	305	25 N.	Swift.
,, Lacerta...	330	48 N.	Very swift.
Near ι Pegasi...	333	27 N.	Swift, streaks.

BEACON LIGHTS AND FOG SIGNALS.[1]

I.

IT is stated by Samuel Smiles in his "Lives of Engineers" that, "with Winstanley's structure on the Eddystone in 1696, may be said to have commenced the modern engineering efforts in directing the great sources of power in Nature for the use and convenience of man," efforts which, followed up by Rudyerd, Smeaton, and others, have been so successful in converting hidden dangers into sources of safety, and insuring the beneficent guidance of the mariner in his trackless path.

The famous structure of Smeaton, which had withstood the storms of more than half a century with incalculable advantage to mankind, became in course of time a matter of anxiety and watchful care to the Corporation of Trinity House, owing to the great tremor of the building with each wave stroke, during heavy westerly storms. The joints of the masonry frequently yielded to the heavy strains, and the sea-water was driven through them to the interior of the building. The upper part of the structure was strengthened with internal ironwork in 1839, and again in 1865. On the last occasion it was found that the chief mischief was caused by the upward stroke of the heavy seas against the projecting cornice of the lantern gallery, thus lifting this portion of the masonry, together with the lantern above it. Unfortunately, the portion of the gneiss rock on which the lighthouse was founded had become seriously shaken by the heavy sea strokes on the tower, and the rock had thus been seriously undermined at its base. The waves rose during storms considerably above the summit of the lantern, thus frequently eclipsing the light, and altering its distinctive character from a fixed light to an occulting. This matter of distinctive character in a beacon light was one of little importance at the date of the erection of Smeaton's lighthouse, when coal fires were the only illuminating agents along the coasts; but with the rapid development of our commerce, and the great increase in the number of coast lights, it has become an absolute necessity that each light maintain a clearly distinctive character. It was therefore determined by the Trinity House, in 1877, to erect a new lighthouse at a distance of 120 feet from Smeaton's tower, where a safe and permanent foundation was found, but at a much lower level, which necessitated the laying of a large portion of the foundation masonry below low water. The foundation-stone of this work was laid on August 19, 1879, by H.R.H. the Duke of Edinburgh, Master of the Trinity House; assisted by H.R.H. the Prince of Wales, an honorary Elder Brother of the Corporation.

On June 1, 1881, H.R.H. the Master, when passing up the Channel in H.M.S. *Lively*, landed at the rock and laid the last stone of the tower; and on May 18 of the following year H.R.H. lighted the lamps, and formally opened the lighthouse. The edifice was thus completed within four years from its commencement, at a cost of £59,255. The work was executed under the immediate direction of the Trinity House and their Engineer, and with a saving of £24,000 on the lowest sum at which it had been found that it could be executed by contract. Every block of granite in the structure is dovetailed together both vertically and horizontally, on a system devised by my father, and first adopted at the Hanois Rock Lighthouse off the west coast of Guernsey. The illuminating apparatus consists of two superposed oil lamps, each of six concentric wicks, and of two drums of lenses of 920 millimetres focal distance, twelve lenses in each drum. The optical apparatus is specially designed on the system of Dr. John Hopkinson, F.R.S., for a double flashing light, and shows two flashes in quick succession, at intervals of half a minute. Attention has of late been directed to the subject of superposed lights in lighthouses, which became a necessity when several small luminaries had to be substituted for the large coal or wood fire of our early lighthouses. The credit of first superposing lighthouse luminaries is doubtless due to Smeaton, who lighted his lantern, in 1759, with twenty-four large tallow candles in two tiers. The idea was followed in 1790 with the first revolving light, established at the St. Agnes Lighthouse, Scilly Islands, which consisted of fifteen oil lamps and reflectors, arranged in three groups, and in three tiers. The number of the lamps and reflectors at this and other first class lights was afterwards extended to thirty, and in four tiers. In 1859, Mr. J. W. D. Brown, of Lewisham, proposed superposed lenses for signal and lighthouse lanterns, with a separate light for each tier of lenses. In 1872, Mr. John Wigham, of Dublin, proposed superposed lenses for lighthouses, in conjunction with his large gas flames, and the first application of these was made in 1877 at the Galley Head Lighthouse, County Cork. In 1876 Messrs. Lepaute and Sons, the eminent lighthouse optical engineers of Paris, made successful experiments with superposed lenses and mineral oil flames, and one of their apparatus was exhibited at the Paris International Exhibition of 1878. The results of these experiments were given by M. Henry Lepaute, in a paper contributed to the Congress at Havre in 1877, of the French Association for the Advancement of Science. The Eddystone represents the first practical application of superposed lenses of the first order, with oil as the illuminant.

The apparatus at the Eddystone is provided with two six-wick burners of the Trinity House improved type, and has a minimum intensity for clear weather of about 38,000 candle units, and a maximum intensity of about 160,000 candle units for atmosphere impaired for the transmission of light. The chandelier light in Smeaton's lantern was unaided by optical apparatus. I have found by experiment that the aggregate intensity of the beam from the twenty-four candles was 67 candle units nearly. The maximum intensity of the flashes now sent to the mariner is about 2380 times that of the candle beam, while the annual cost for the mineral oil illuminant is about 82 per cent. less.

The sound signal for foggy weather consists of two bells of 40 cwt. each, mounted on the lantern gallery, and rung by machinery. If any wind occurs with the fog, the windward bell is sounded. The distinctive character of the signal is two sounds of the bell in quick succession every half-minute, thus corresponding with the character of the light signal.

The tendency of the curvilinear outline near the base of Smeaton's and of other similar sea towers that have followed it, to elevate the centre of force of heavy waves on the structure, induced me to adopt a cylindrical base for the new lighthouse, which is found to retard the rise of waves on the structure, while it affords a convenient platform for the lightkeepers, and adds very considerably to their opportunities for landing and relief. The Town Council and inhabitants of Plymouth having expressed a desire that Smeaton's lighthouse should be re-erected on Plymouth Hoe, in lieu of the Trinity House sea mark thereat, the Trinity House, who, as custodians of public money, had no funds available for such a purpose, undertook to deliver to the authorities at Plymouth, at actual cost for labour, the lantern, and the four rooms of the tower. These have been re-erected by public subscription on a frustrum of granite, corresponding nearly with the lower portion of Smeaton's tower, and it is to be hoped that it will be preserved by the town of Plymouth as a monument to the genius of Smeaton, and in commemoration of one of the most successful and beneficent works in civil engineering.

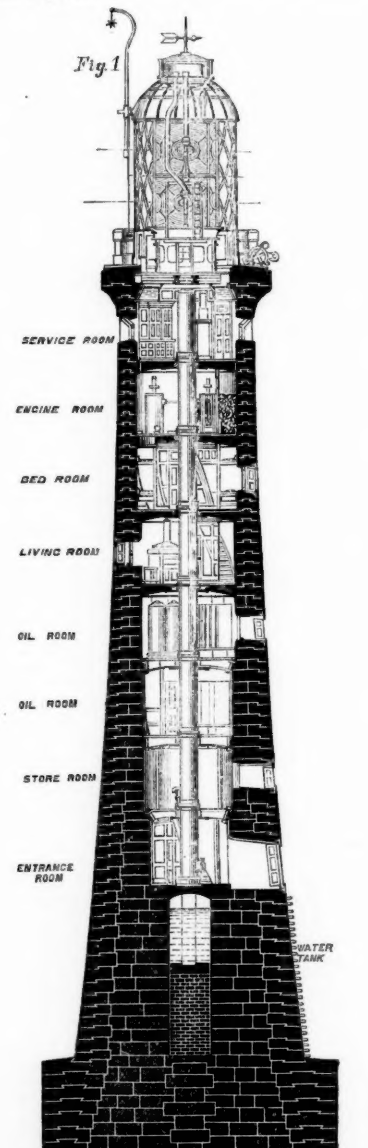
It is extremely difficult to estimate, with a fair degree of accuracy, the maximum force of the waves with which some of the most exposed of these sea structures may occasionally have to contend. The late eminent lighthouse engineer, Mr. Thomas Stevenson, F.R.S.E., carried out a long series of experiments with a self-registering instrument he devised for determining the force of sea-waves on exposed structures. He found at the Skerryvore Rock Lighthouse the Atlantic waves there gave an average force for five of the summer months in 1843-44 of 611 pounds per square foot. The average result for the six winter months of the same year was 2086 pounds per square foot, or three times as great as in the summer months. The greatest force registered was on March 29, 1845, during a westerly gale, when a pressure of 6083 pounds, or 2¾ tons nearly, per square foot was recorded. After Smeaton had carefully considered the great defect of the building of Rudyerd at the Eddystone, viz. want of weight, he replied that, "if the lighthouse was to be so contrived as not to give way to the sea, it must be made so strong as that the sea must be compelled to give way to the building." Smeaton also had regard to durability as an important element in the structure, for he adds: "In contemplating the use and benefit of such a structure as this, my ideas of what its duration and continued existence ought to be were not confined within the boundary of one age or two, but extended themselves to look towards a possible perpetuity." Thus Smeaton soon arrived at the firm conviction that his lighthouse must be built of granite, and of this material nearly all lighthouses on exposed tidal rocks have since been constructed, while those on submerged sandbanks are open structures of iron, erected on screw piles or iron cylinders. The screw pile was the invention of the late Mr. Alexander Mitchell, of Belfast.

We have here a model of the first lighthouse, erected in 1838,

[1] Friday evening discourse delivered at the Royal Institution by Sir James N. Douglass, F.R.S., on March 15. We are indebted to the Editor of the *Engineer* for the use of the woodcuts illustrating this discourse.

on these screw piles, at the Maplin Sand, on the north side of the estuary of the Thames, under the direction of the late James Walker, F.R.S., then Engineer-in-Chief to the Trinity House. A lighthouse on the principle of minimum surface exposed to the force of the waves, of which we have here a model, was erected on the chief rock of the dangerous group of the Smalls, situated about 18½ miles off Milford Haven, by Mr. John Phillips, a merchant and shipowner of Liverpool. The work was designed, and erected under great difficulties, by Mr. Henry Whiteside, a native of Liverpool, and a man of great mechanical skill and undaunted courage. Added to his mechanical ability, Whiteside possessed a great love and knowledge of music, and had, previous to the erection of his lighthouse, excelled in the construction of violins, spinnettes, and upright harpsicords. The lighthouse, commenced in 1772, was intended to be erected on eight cast-iron pillars, sunk deep into the rock; this material was, however, soon abandoned for English oak, as being more elastic and trustworthy. The work was completed and lighted in 1776 with eight lamps and glass faceted reflectors, similar to the one before us. In 1817 sixteen improved lamps and silvered paraboloidal reflectors were substituted for these; and the lighthouse, although sorely tried by winter storms, was (with the aid of yearly repairs and strengthening) enabled to send forth its beneficent beam until the year 1856, when the Trinity House commenced the erection of a lighthouse of granite, as shown by this model. The vibrations of the old wooden structure must have been very considerable with heavy storms, for the lightkeepers occasionally found it sufficient to cause a bucket of water, placed in the living-room, to spill just half its contents. It was in this lighthouse that the painful circumstance occurred in the year 1802 of the death of one of the lightkeepers. In those days only two men inhabited the lighthouse at a time; one of them was taken ill, and the means employed by his companion for obtaining relief proved ineffectual; he hoisted a signal of distress, but owing to stormy weather no landing could be effected, and after many days of extreme suffering, the poor fellow, named Thomas Griffiths, breathed his last, when the survivor, Thomas Howell, fully realized the awful responsibilities of his position; decomposition would quickly follow, and the atmosphere of the small apartment would be vitiated. The body could not be committed to the sea, as suspicion of murder would probably follow. Howell was a cooper by trade, and he was thus enabled to make a coffin for his dead companion out of boards obtained from a partition in the apartment. After very great exertion the body was carried to the outer gallery, and there securely lashed to the railing. For three long weeks it occupied this position before the weather moderated, yet night after night Howell faithfully kept his lights brightly burning. When a landing was at last effected, his attenuated form demonstrated the sufferings, both mental and physical, he had undergone; indeed, several of his friends failed to recognize him on his return to his home. Since this sad occurrence the Trinity House have always maintained three lightkeepers at their isolated rock stations. The present lighthouse was designed by the late Engineer-in-Chief of the Trinity House, Mr. James Walker, F.R.S., and I had the honour of executing the work as resident engineer. The foundation-stone was laid on June 26, 1857, and the light was exhibited on August 7, 1861. The work was completed by the Trinity House, at a cost of £50,125, being about 24 per cent. under the lowest amount at which it had been ascertained that it could have been executed by contract.

Probably the most exposed rock lighthouse is that on the Bishop (the westernmost of the rocks of Scilly), shown in Fig. 1. Its position is doubtless one of the most important to mariners, warning them, as it does, of the terrible dangers where, on October 22, 1707, Sir Cloudesley Shovel, with the *Association*, *Eagle*, and *Romney*, were lost, with about 2000 men. The Bishop is also the guiding light for the entrances to the English and Bristol Channels. The rock, composed of a very hard, pink-coloured granite, is about 153 feet long by 52 feet wide at the level of low water of spring tides. It stands in over 20 fathoms water, is steep to, all round, and is exposed to the full fury of the Atlantic. It was at first feared that the width of the rock was not sufficient for the base of a stone tower of adequate dimensions to withstand the heavy wave-shocks it would have to resist, and an open structure of wrought and cast iron [shown on the diagram] was determined on. The work was jointly designed by the late Engineer-in-Chief to the Trinity House and my father, the superintending engineer, who afterwards erected the structure, at which I had the honour of acting as assistant engineer.



The work was commenced in 1847, and at the end of the working season of 1850 the lighthouse was so far completed as

to be in readiness for receiving the lantern and the illuminating apparatus, and it was left with confidence to resist the storms of the approaching winter. But during a very violent storm, between 11 p.m. of the 5th and 3 a.m. on the 6th of the following February, the lighthouse was completely destroyed, and swept from the rock. On further consideration of the matter, the Trinity House determined, on the recommendation of their engineers, to proceed with a stone structure, and my father was appointed to build the lighthouse, I acting as before as assistant engineer. The work was proceeded with in the spring of 1851. In order to obtain the greatest possible diameter of base for the tower that the rock would admit of, it was found necessary to lay a portion of the foundation on the most exposed side of the rock, at the level of 1 foot below low water of spring tides; and, although every possible human effort was made by the leader and his devoted band of workers, the foundations were not completed until the end of the season of 1852. Soon after this, my brother, Mr. William Douglass, now Engineer-in-Chief to the Commissioners of Irish Lights, succeeded me as assistant engineer at the work. The lighthouse was completed in 1858, and its dioptric fixed oil light of the first order was first exhibited on September 1 of that year. Soon afterwards, its exposure to heavy seas during storms was fully realized. On one occasion the fog bell was torn from its bracket at the lantern gallery at 100 feet above high water, and the flag-staff, with a ladder, which were lashed outside the lantern, were washed away. The tremor of the tower on these occasions was such as to throw articles off shelves, and several of the large glass prisms of the dioptric apparatus were fractured. After some time it was found that several of the external blocks of granite situated a few feet above high water were fractured by the excessive strains on the building. In 1874 the tower was strengthened from top to bottom by heavy iron ties, bolted to the internal surface of the walls; but, after a violent storm in the winter of 1881, there was evidence of further excessive straining at the face of the lower external blocks of masonry, when the Trinity House, on the advice of their engineer, determined on the re-erection of the lighthouse. This was accomplished (as shown in Fig. 1) by incasing the existing tower with carefully dovetailed granite masonry, each alternate block of the new granite being dovetailed to the old. The work was one of considerable difficulty, owing to the necessity for maintaining the light throughout the progress; and the risk to the workmen was great, especially at the upper part of the old tower, owing to the narrow ledge on which the work had to be executed. I am, however, thankful to state that the new lighthouse has been successfully completed by my son, Mr. W. T. Douglass, who was also my assistant engineer at the Eddystone; and with the same complete immunity from loss of life or limb to any person employed, as with the two previous structures on this rock. The optical apparatus consists of two superposed tiers of lenses of the type adopted at the Eddystone, but of larger dimensions, as suggested by the late Mr. Thomas Stevenson, for obtaining greater efficiency with the larger-flame luminaries recently adopted. The apparatus is provided with two Trinity House improved mineral oil burners, and has a minimum intensity for clear weather of about 80,000 candle units, and a maximum intensity for thick weather of about 513,000 candle units. The character of the light is double-flashing, showing two flashes, each of four seconds' duration, in quick succession, at periods of one minute. The flashes of this light, and those of a light lately completed at about 8 nautical miles from it, on Round Island, are the most intense yet attained with oil flames for beacon lights; and it may be stated that, with no other illuminant at present known to science could these results be carried out within the space available at the Bishop Rock, and under the circumstances attending that work. The fog signal recently adopted at this station, in lieu of the bell, is by the electrical explosion of 4-ounce charges of gun-cotton, at intervals of 5 minutes. The apparatus provided for this form of fog signal is shown in Fig. 1. It consists of a wrought-iron crane (attached to the lantern) which is raised and lowered by a worm-wheel and pinion. When the crane is lowered, its end reaches near the gallery, where the lightkeeper suspends the charge of gun-cotton, with its detonator attached, to the electric cable, which is carried along the crane and through the roof of the lantern to a dynamo-electric firing machine. After suspending the charge, the jib of the crane is raised to its upper position, when the charge is fired nearly vertically over the glazing of the lantern, and thus without causing damage to it. The large and heavy optical apparatus is rotated automatically by compressed air, which is stored in two vertical steel reservoirs, fixed at the centre of the tower. The air is compressed by a small Davey safety motor. A winch, worked by the compressed air, is fixed on the lantern gallery for landing the lightkeepers, stores, &c. Fig. 2 is a sketch, from actual observation, of the height and form of waves on the tower during a storm.

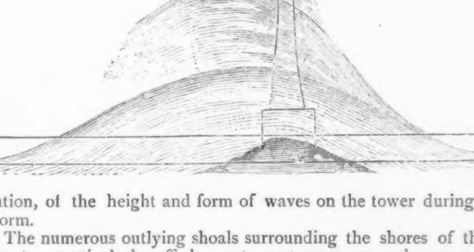
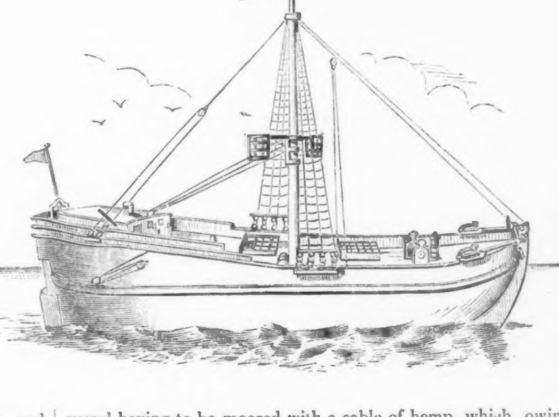


FIG.2

The numerous outlying shoals surrounding the shores of this country, particularly off the east coast, were an early cause of anxiety to those responsible for the guidance of mariners. And in addition to buoys as sea-marks by day, floating lights, as guides by night, were found to be a necessity. The first light-vessel was moored at the Nore Sand in 1732, and another near the Dudgeon Shoal in 1736. We have here a model of the latter vessel, from which we may judge of the pluck and hardihood of the crews who manned them, especially when we remember that there were no chain cables in those days, the vessel having to be moored with a cable of hemp, which, owing to the constant chafing, occasionally parted during winter storms, when, to save their lives, the crew had to put out another anchor if possible, or set such storm canvas as they could to keep her off a lee-shore, and endeavour to reach a place of safety. The illuminating apparatus of these vessels consisted of a small lantern and flat-wick oil lamps, fixed at a yardarm, and here appears to have occurred the first application of a distinctive character to beacon lights, for the *Dudgeon* was fitted with two lights, one being placed at each arm of the yard (Fig. 3). The next light-vessel was placed at the Newarp Shoal in 1790, and in 1795 one was placed at the north end of the Goodwin Sands.

Fig. 3

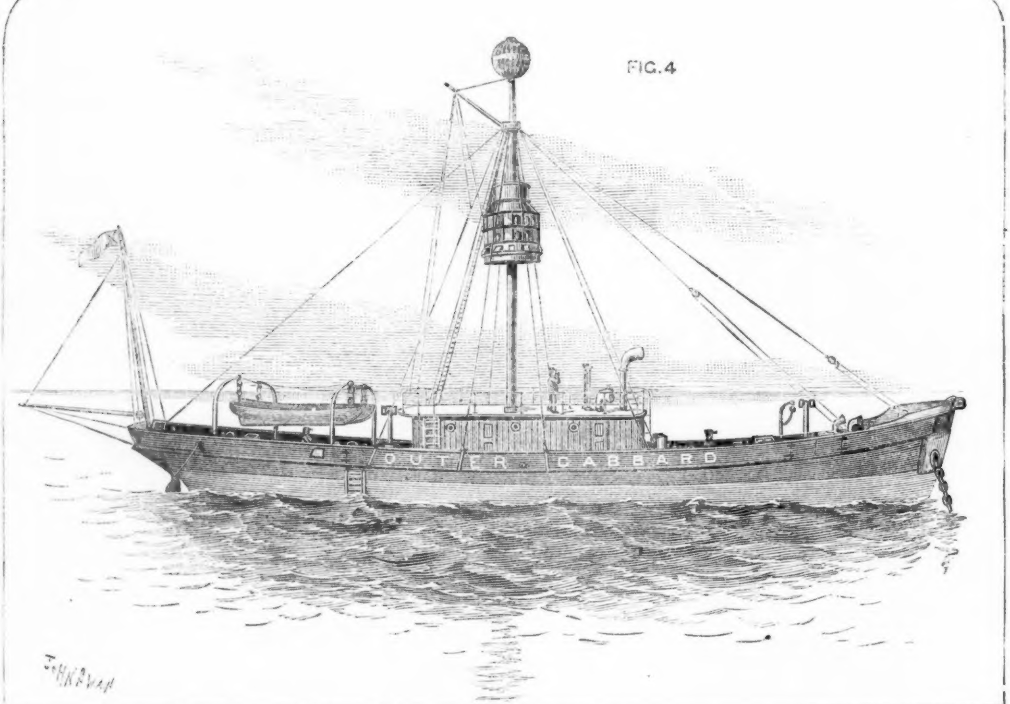


The two latter vessels were provided with three fixed lights, and the lanterns were larger, and surrounded each mast-head, as shown by the model before us. An improvement was also effected in these lights by providing each lamp with a silvered reflector.

In 1807 the late Mr. Robert Stevenson, the engineer of the Bell Rock Lighthouse, to whom and his successors are due much valuable engineering and optical work connected with coast-lighting, designed a larger lantern to surround the mast, and capable of being lowered to the deck for properly trimming the lamps (Fig. 4). Soon after the adoption of the system of catoptric illumination in lighthouses, it was extended to floating lights; each lamp and reflector was hung in gimbals, to insure horizontal direction of the beams of light during the pitching and rolling of the vessel. We have here one of these apparatus. The intensity of the beam sent from it was 500 candle units, nearly.

On January 1, 1837, the Trinity House installed the first revolving floating light, at the Swin Middle, and later in the same year another, on board the *Gull* light-vessel. The lamps and reflectors were carried on a roller frame surrounding the mast, and rotated through light shaftings by clockwork placed between decks. There were nine lamps and reflectors arranged in three groups, of three each, and thus the collective intensity of each flash was equal to that of three fixed lights, or 1500 candle units, nearly. In 1872 the Trinity House further increased the dimensions of the lanterns and reflectors of their floating lights—the lanterns from 6 to 8 feet in diameter, with cylindrical instead of polygonal glazing, and the reflectors from 12 inches to 21 inches diameter at the aperture. These improvements, together with the adoption of improved burners, have effected a considerable increase in the intensity of these lights; and during the last two years a further improvement has been obtained by the adoption of concentric wick burners with more condensed flames, and of higher illuminating power, by which the intensity of the beam from each reflector has been raised to 5000 candle units, being just ten times the intensity of the smaller apparatus; while, by the adoption of mineral oil in lieu of colza, the annual cost for the illuminant has been reduced 50 per cent.

FIG. 4



Dioptric apparatus was proposed for light-vessels by M. Letourneau in 1851, several small fixed-light apparatus being intended to be employed in each lantern, and arranged nearly in the same way as the reflectors. This arrangement has been adopted in some instances by Messrs. D. and T. Stevenson, Engineers to the Commissioners of Northern Lighthouses, and by the engineers of the French Lighthouse Service; but, for efficiency and adaptability to meet the rough duty to which floating lights are occasionally subjected in stormy weather and collisions, this system has been found to be inferior for this service to the catoptric.

An interesting experiment was recently made by the Mersey Docks and Harbour Board with the electric arc light, on board one of their light-vessels, at the entrance of the Mersey; but unfortunately it did not prove successful. The present difficulties experienced afloat with this powerful illuminant will doubtless be overcome, and it will be found to be, as in lighthouses, by far the most efficient illuminant for some special stations, where a higher intensity than can be obtained with flame luminaries is demanded. Experiments have been in progress during the past two years at the *Sunk* light-vessel, off the coast of Essex, for maintaining electrical telegraphic communication with the shore for reporting wrecks and casualties in the locality. This vessel is connected with the post office at Walton-on-Naze, through nine miles of cable. The instruments adopted are the Wheatstone ABC Morse, and the Gower Bell telephone, the telephone for the first time for this purpose on board a vessel at sea, and its efficiency has been found to be so perfect that it is preferred by the operators to the telegraphic instruments. Many difficulties have been experienced in maintaining trustworthy communication during stormy weather, owing to consequent wear and tear of the connections with the vessel, but the system, which was designed

and carried out by the Telegraph Construction and Maintenance Company, is now working satisfactorily. Unfortunately, however, it is found to be too costly for adoption except in very special cases.

(*To be continued.*)

A BILL TO PROVIDE TECHNICAL EDUCATION IN ENGLAND AND WALES.

THE following Bill, introduced into the House of Commons by Sir Henry Roscoe on behalf of the National Association for the Promotion of Technical Education, was read a second time without opposition on Wednesday, May 8 :—

Whereas it is expedient that due provision should be made for technical education in public elementary schools and elsewhere :

Be it therefore enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows :

1. This Act may be cited as the Technical Education Act, 1889.

2. (1) After the *passing of this Act* any school board may make provision for giving technical education in any school under their management, and either by day or evening classes, or both, as may seem fit, having regard to the daily occupations of the persons to be benefited thereby.

(2) If no such provision is made, or if it is insufficient, and if the local authority by special resolution determine that provision or further provision ought to be made, they may themselves make such provision.

3. Where technical education is given in any school, not being a public elementary school (including for the purposes of this section any college), which is not under the management of a school board or local authority, and is either within their district or accessible to the inhabitants thereof, the school board or local authority may contribute or they may join together with other school boards or local authorities in contributing from their respective funds towards—

(*a*) the maintenance or improvement of that school or of its provisions for technical education ; or

(*b*) the payment of the fees at that school of deserving students who before proceeding to such school have been resident in the district of the contributing board or authority ;

(*c*) the establishment of scholarships for deserving students.

The mode in which and the terms upon which contributory school boards and local authorities shall be represented upon the governing bodies of schools receiving such contributions, so far as technical instruction is concerned, shall be such as may be agreed upon between the school boards, local authorities, and governing bodies respectively in each case.

Every such contribution shall be deemed to be expenses of such school board or local authority incurred for the purposes of this Act.

4. (1) *Where any school in which technical education is given in pursuance of this Act is also a public elementary school, a parliamentary grant may be made to such school by the Education Department and by the Science and Art Department, or by either of such Departments.*

(2) *The conditions required to be fulfilled by such school in order to obtain an annual parliamentary grant shall be those contained in minutes issued by the Committee of Council on Education.*

(3) Any minute made in pursuance of this section shall not come into force until it has lain on the table of both Houses of Parliament for one month.

5. (1) *Where any school in which technical education is given in pursuance of this Act is not a public elementary school, a parliamentary grant may be made to such school by the Science and Art Department, subject to such conditions as that Department may prescribe.*

(2) Any minute made by the Science and Art Department in pursuance of this section shall not come into force until it has lain on the table of both Houses of Parliament for one month.

6. (1) All the provisions of the Elementary Education Acts relating to the powers of school boards with respect to sufficient accommodation, fees, the combination of school boards, and the acquisition of land, shall apply to school boards in whose schools technical education is given, or to be given, under this Act ; and a school shall not cease to be a public elementary school within the meaning of the Elementary Education Acts by reason of technical education being given therein.

(2) A school which is under the management of a school board, and in which technical education is given under this Act, shall be conducted in accordance with the same regulations as an elementary public school under the Elementary Education Acts : Provided, however, that every such school shall be open to the inspection of any inspector appointed by the Department of Science and Art, as well as of Her Majesty's inspectors as defined in the Elementary Education Acts.

7. The expenses incurred by any school board in carrying this Act into effect, including any contributions made by the school board in aid of technical education in schools not under their management, shall be deemed to be expenses of the said school board within the meaning of the Elementary Education Acts, and payable accordingly.

A school board shall have the same powers of borrowing for the like purposes, but subject to the same consent and other conditions, as they have under the Elementary Education Acts.

8. The expenses incurred by a local authority in giving effect to this Act, including any such contributions as are above mentioned, shall be payable out of the local rate. The local authority shall have the like powers of borrowing for the purposes of this Act, but subject to the same conditions, as for other purposes.

9. The provisions of this Act with respect to a local authority shall not apply to the Metropolis.

10. It shall be competent for any school board or local authority, should they think fit, to institute an entrance examination in reading, writing, and arithmetic for persons desirous of attending technical schools or classes under their management, or to which they contribute.

11. For the purposes of this Act the expression "technical education" means instruction in—

(i.) Any of the branches of Science and Art with respect to which grants are for the time being made by the Department of Science and Art.

(ii.) The working of wood, clay, metal, or other material for the purposes of art or handicraft.

(iii.) Commercial arithmetic ; commercial geography ; modern languages ; book-keeping, and shorthand.

(iv.) Any other subject applicable to the purposes of agriculture, trade, or commercial life and practice, which may be sanctioned by a minute of the Department of Science and Art made on the representation of a school board or local authority that such a form of instruction is suited to the needs of its district.

12. The provision to be made for technical education under this Act may include the providing of school laboratories, apparatus for teaching and experiment, museums and their contents, libraries, books, workrooms, schools or schoolrooms, or the improvement of existing provisions of any of these kinds, and the maintaining of the same in such manner as may be necessary to give effect to this Act.

13. (1) Save as otherwise provided by this Act the expressions "school board," "public elementary school," "managers," "parliamentary grant," and "Education Department," respectively, have the same meaning in this Act as in the Elementary Education Acts.

(2) The expression "local authority" means in any borough the council of that borough, and elsewhere the district council if district councils are established under any Act of the present session of Parliament, but if not then the urban sanitary authority or where there is no urban sanitary authority the county council.

The expression "local rate" means in a borough the school fund or borough fund or borough rate, and elsewhere the general district rate or other rate corresponding thereto.

14. This Act shall not apply to Scotland or Ireland.

SCIENTIFIC SERIALS.

Bulletins de la Société d'Anthropologie, tome onzième, série iii., fasc. 4 (Paris, 1888).—Conclusion of M. Variot's paper on the removal of marks of tattooing ; and on an instrument for tattooing, by the same writer.—On the sacrum of a chimpanzee, by M. Chudzinski. In this case the sacrum was composed of seven vertebræ, the normal number in the Anthropoids being only five, or at most six.—A process for mounting histological specimens

treated under paraffin, by M. Mahoudeau.—A description of the cranium and brain in two assassins, by MM. Fallot and Alezais. This communication gives a minute analysis of the convolutions and other parts of the hemispheres, while it supplies numerous and special measurements of the various parts of the skull together with the respective cerebral and cranial indices.—On the cranial alterations observable in rachitic conditions, by M. Regnault —On the first temporal convolution in the right and left hemispheres, in the case of a person who was known to have suffered from deafness of the left ear, by M. Manouvrier.—A communication regarding the truth of the reports made by various travellers that cannibalism exists among the Fuegians, by M. Hyades. According to this writer there is absolutely no ground for this charge.—On a Peruvian bell, by M. Verneau.—On the antiquity of Egypt, and the evidences of its condition in prehistoric times, by M. Beauregard. In this very exhaustive article the author passes in review the material evidence remaining of the ages of cut and polished stone and of bronze. He believes that Egypt at the time of the Pharaohs exhibited the mixed condition of combining the use of flint implements with the simultaneous acquaintance with the means of extracting copper, and blending it with other metals, including tin, although no distinct hieroglyphic for the latter has been recognized in the older language of Egypt. It remains undetermined where and when first the ancient Egyptians obtained the tin which enters into the bronze fabricated in the valley of the Nile as far back as the seventeenth century before our era.—On the birth rate in France, by M. Chervin. This paper contributes the most elaborate and detailed series of statistical tables, for the separate departments, of the births, marriages, and deaths registered, as well as of the numbers of children born in a definite number of households. The means obtained from these lists show that 8 per cent. of all the marriages in France are sterile, and that while 25 per cent. yield only one child, 100 families supply a mean of only 259 children. Many curious points of interest are suggested by this complex report, but it does not do much to explain the causes of the want of increase in the population of France, as compared with that of other countries.—On the hinged and cantoned cross in Cyprian decorative art, by M. Max Richter. The remains of ancient art in Cyprus strongly resemble those of Hissarlik, excepting that there is no trace of the *swastika*, or hinged cross on the decorated red jars of the Bronze Age, while its later appearance and disappearance in Cyprian art appears to coincide with the predominance and decline of Phœnician influence.—On the survival in Brittany of some of the usages and privileges of clanship, by M. Sébillot.—On a semi-pagan procession on St. John's day, in the Basses Alpes, by M. Arnaud. From time immemorial the peasants of Lauzet have proceeded after the benediction of the neighbouring lake to throw stones into its waters amid loud and angry cries of vengeance against the evil spirits who bring rain and hail storms. In this strange ceremony the local *curé* is constrained by popular will to take part.—On phallotomy among the Egyptians, by M. Letourneau.—On the centre of creation, and the first appearance of the human race, by M. Lombard. The writer supports Signor Saporta's view that vegetable forms, which now cover our continents, have spread slowly and continuously from north to south, recent species forcing back or obliterating those of more ancient origin. The laws which Signor Saporta endeavours to establish for the diffusion of vegetable forms, M. Lombard thinks may be extended to the animal kingdom, including man, whose cradle he would seek in circumpolar regions.—Report of sixth Conference on Transformism, under the presidency of M. Duval, by M. Bordier.—Report of fifth Broca-Conference, by M. Topinard, a member of the commission for awarding the prize instituted by Madame Broca in memory of her husband. The memoirs presented between 1885 and 1888 are not numerous, but great value attaches to two among these works, viz. the general ethnography of Tunis, by Dr. René Collignon, to whom the Broca Prize for 1888 has been unanimously awarded; and ethnological researches in regard to the human remains discovered at Spy, by M. Fraipont, who received a silver medal in recognition of the great merit of his work.—On the longevity of the Berber races, by M. Letourneau.—On a Palæolithic station on Mont Roty, and on a novel flint implement, by the Abbé Blanquet.—On an ancient cemetery at Biskra, Algeria, by M. de Mortillet.—On a sepulchral dolmen, discovered at Nanteuil-le-Houdouin (Oise), by MM. Collin and Lair.—A prehistoric station at Frileuse (Seine-et-Oise), by M. Vauvillé.

THE numbers of the *Botanical Gazette* (Crawfordsville, Indiana) for March and April contain a careful study of the histology of the leaves of *Taxodium* by Mr. Stanley Coulter, and a description of a number of new North American mosses, with illustrations, by Messrs. Renauld and Cardot. It is an evidence of the attention paid in the United States to microscopical technique, that this magazine frequently contains (as do both the numbers now before us) valuable hints as to the preparation of sections of tissues for the microscope, the use of staining reagents, or objects specially well calculated to demonstrate difficult points of structure.

IN the *Journal of Botany* for April and May, Messrs. Murray and Boodle complete their account of the genus *Avrainvillea* of Siphonocladaceæ.—Students of conifers will read with very great interest Dr. M. T. Masters's attempt to distinguish the North American pines, *Abies lasiocarpa*, *A. bifolia*, and *A. subalpina*, with their varieties or subspecies. The paper is illustrated by a series of excellent woodcuts.—Most of the other papers in these numbers are of special interest to students of British plants.

THE *Nuovo Giornale Botanico Italiano* for April, a large portion of which is devoted to a report of the proceedings of the Italian Botanical Society, contains several articles of general interest besides those devoted to the Phanerogamic and Cryptogamic botany of Italy.—Dr. H. Ross has an interesting article on the assimilating tissue and development of the periderm in the branches of plants with few or no leaves.—In pursuance of his careful examination of the Nymphæaceæ, Prof. G. Arcangeli now contributes a paper on the seeds of *Victoria regia*.—Signor U. Martelli adds a species to the few hitherto known of the genus *Riccia*—*R. atromarginata* from Sicily.—Signor C. Lumia gives the result of an examination of the composition of the gas found within the inflorescence of the common fig in an unripe condition, which contains more than 5 per cent. of carbon dioxide, showing that an active process of respiration must go on within the receptacle.—Signor G. Cuboni gives an account of experiments carried on with a view to check the plague of grasshoppers by infecting them with a parasitic fungus, *Entomophthora Grylli*, which had, however, only negative results.

Rendiconti del Reale Istituto Lombardo, April.—Palæontological notes on the Lower Lias of the Lombard fore-Alps, by Dr. C. F. Parona. These notes are communicated pending the publication of the author's exhaustive treatise on the fauna of Saltrio. They deal especially with the palæontological features of the Bergamo and Como districts in connection with the various faunas that flourished in the Lombard Sea during the Lower Lias epoch. The results of this summary survey agree generally with the conclusions arrived at by Prof. De Stefani in his comparative study of the various Lower Lias formations throughout Italy.—New measurement of the curvature of surfaces, by Prof. Felice Casorati. A new solution is presented of this problem, that of Gauss being shown to be defective and inadequate, although he laid the first solid foundation for the study of the subject in his classical work, "Disquisitiones generales circa superficies Curvas."—Prof. Giovanni Zoja contributes some historical notes on the cabinet of human anatomy in the University of Pavia, dealing more particularly with the period from 1815 to 1864 under the able administration of Bartolomeo Panizza.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 9.—"Zirconium and its Atomic Weight." By G. H. Bailey, D.Sc., Ph.D., the Owens College, Manchester.

Before proceeding with any final estimation, those salts of zirconium which were at all likely to be of service in the determination were exhaustively examined with special regard to their stability in presence of reagents and under the action of heat.

It was found that in consequence of their instability and tendency to form numerous oxychlorides, neither the chloride nor the oxychloride could be relied upon, and that the sulphate was the most suitable salt to work with. Even this salt when heated above 400° C. undergoes gradual decomposition with the production of basic salts, though it is quite stable up to this temperature A special method (applicable in a number of

other atomic weights) was devised by which the normal salt could be obtained free from acid on the one hand, and from basic salt on the other. In order to have a sufficient check on the results, the carefully purified zirconia was further treated by four perfectly independent methods.

(*a*) The sulphate was prepared and its solution precipitated by means of hydrogen peroxide.

(*b*) The tetrachloride was prepared and its solution precipitated by ammonia.

(*c*) The sulphate was recrystallized several times from concentrated sulphuric acid and precipitated by ammonia.

(*d*) The oxychloride was prepared and recrystallized and precipitated by ammonia.

The average values obtained from the sulphate prepared from the specimens of zirconia so treated by determining the relation $Zr(SO_4)_2 : ZrO_2$, were :—

$$\left.\begin{array}{l}(a)\ 90\cdot402\\(b)\ 90\cdot390\\(c)\ 90\cdot471\\(d)\ 90\cdot30\end{array}\right\}\text{ mean } 90\cdot401.$$

In addition to the investigation of the salts which have been used in the estimation of the atomic weight, observations on the peroxides of zirconium discovered by Clève and the author are embodied, as well as an examination of the so-called metallic zirconium.

"Determining the Strength of Liquids by means of the Voltaic Balance." By Dr. G. Gore, F.R.S.

This method is based upon the circumstance that the greater the degree of concentration of a solution the larger is the amount of dilution required to reduce its voltaic energy to a given magnitude. The method of measuring the energy is described in Royal Society Proceedings, vol. xlv. p. 268.

In the present research a known volume of solution was taken, and the proportion of dissolved substance in it was found by ordinary chemical analysis. A second portion was taken, its specific gravity ascertained, and its degree of strength found by aid of the ordinary published tables of specific gravities. A third portion of known volume was then taken, its average amount of voltaic energy measured, and its degree of concentration ascertained by the amount of dilution required to reduce its voltaic energy to the same magnitude; the less dilute it was at starting the greater the amount of dilution required. The following are the results :—

By	HCl.	H_2SO_4.	HNO_3.	NaCl.	Na_2CO_3.	H_3N.
Chemical analysis ...	1·85 ...	5·60 ...	2·97 ...	9·13 ...	7·21 ...	1·05
Specific gravity ...	1·70 ...	5·44 ...	2·80 ...	8·74 ...	7·63 ...	1·03
Voltaic balance ...	1·65 ...	5·70 ...	2·90 ...	8·71 ...	7·57 ...	1·06

A much less quantity of the substance is usually required by the voltaic balance method than by either of the other ones, and the operation is very quickly performed.

Physical Society, May 11.—Prof. Reinold, President, in the chair.—The following communications were read :—On an electrostatic field produced by varying magnetic induction, by Dr. O. J. Lodge, F.R.S. This paper describes a research made with the object of finding some connection between static electricity and magnetism. Several methods of attacking the problem, such as rotating or varying the strength of magnets in the neighbourhood of delicately suspended charged bodies, are indicated, and the one selected was based on an idea of Mr. A. P. Chattock, who conceived that a charged body in the vicinity of a closed magnetic circuit would be affected by varying the magnetic induction. From the theory of the effect it is shown that the magnitude of the quantity sought is exceedingly small, for the expression involves the inverse square of the velocity of light. The E.M.F. induced in any closed curve round the magnetic circuit or solenoid by varying the induction, I, is given by—

$$e = \frac{dI}{dt} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ (1)$$

If an E.M.F., e, act on a charge, Q, at distance r from the axis of the solenoid, the work done in one revolution will be eQ, and

$$eQ = F \,.\, 2\pi r \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ (2)$$

where F is the mechanical force. Now if the E.M.F. in (1) is the same as that in (2), the impulse given to the charged body by destroying the induction will be—

$$\phi = \int_0^\infty F dt = \frac{IQ}{2\pi r} \quad . \ . \ . \ . \ . \ . \ . \ . \ (3)$$

Since $I = \frac{4\pi n C A\mu}{l} = \mu C$ times a length, and $Q = sV = KV$ times a length,

$$\therefore \phi = \frac{K\mu CVA}{2\pi r} (\text{length})^2, \text{ and } K\mu = \frac{1}{\text{“}v\text{”}^2}; \ \therefore \phi \propto \frac{1}{\text{“}v\text{”}^2}.$$

The magnetic circuit actually used was a wire Gramme ring of trapezoidal section, wound with copper over only a part of its periphery. The indicating apparatus was a suspended needle, consisting of two oppositely charged bodies carried on a small shellac arm, to which a mirror or pointer was attached, and was suspended vertically in the plane of the ring. Great difficulty was experienced from Foucault's currents when metallic films were used for the needle, and the magnetic properties and other semi-conductors tried further complicated the matter. Eventually, the charged bodies were made of paper, in the form of cylinders one-eighth of an inch diameter and three-eighths of an inch long. Considerable trouble was caused by the electrostatic action between the needle and exciting coils, and various methods of screening were tried and abandoned, and subsequently the wire was replaced by a single spiral of copper ribbon, the outer turn of which was put to earth. Observation was rendered difficult, owing to the wandering of the zero when the needle was charged, but this was minimized by suitably shaping the contour of the needle's surroundings. Heat also created considerable disturbance, and the convection currents were cut off by a series of concentric cylinders of tin plate. The method of observation was to charge the two insulated parts of the needle, and then reverse the magnetizing current in synchronism with the period of the needle, noting whether the amplitude of any residual swing could be increased or diminished according as the impulse assisted or opposed the motion. In this way, slight indications have been observed, and the effects reverse when the charges of the cylinders are reversed. In explaining the theory of the experiment, the author made use of a simple transformer, consisting of an ordinary hank of iron wire wound over with insulated copper and provided with several secondary coils; and by it he demonstrated that the primary current increases on closing the secondary, due, as was shown, to the decrease of self-induction of the primary caused thereby. Prof. Fitzgerald, in answer to a question from Dr. Lodge as to the influence of screens, said he had not fully considered the matter in this particular case, and, as the general effect of screens depended on the square of "v," the subject required careful treatment. As a means of checking the results obtained by Dr. Lodge, he suggested calculating the impulse, and seeing whether its magnitude approximately corresponds with that observed. Commenting on an idea for carrying out a similar experiment attributed to him in the paper, in which a charged gold leaf is placed between the poles of a magnet, Prof. Fitzgerald said he had been misunderstood, for he had conceived a disk parallel to the faces of the magnets, which, when excited, should cause the disk to turn in its own plane. Referring to the equations for mechanical force given in Maxwell, § 619, he pointed out that the coefficient of e in the equation—

$$X = cv - bw - e\frac{d\psi}{dx} - m\frac{d\Omega}{dx}$$

ought to be P, where—

$$P = c\dot{y} - b\dot{z} - \frac{dF}{dt} - \frac{d\psi}{dx},$$

and considered it very important that the existence of the term $e\frac{dF}{dt}$ should be tested experimentally. Prof. S. P. Thompson mentioned some experiments on which he was engaged by which he hoped to show electric displacement in continuous dielectric circuits, such as a link of gutta-percha. Up to the present the experiments had not been successful, owing to his inability to place the two Gramme ring coils used into such relative positions as to give silence in the telephone connected with the coil used as secondary, when currents were sent through the primary. Prof. Ayrton suggested that Dr. Thompson's difficulty may arise from the fact that such rings do produce considerable external field, even when carefully wound.

Prof. Fitzgerald requested Dr. Thompson to investigate the effects of displacement-currents and of changing vector potential, and pointed out that in a single medium the former can produce no magnetic effect. As regards fields containing different media, he said the calculations would be complicated by the spurious charges on the separating surfaces. Dr. Lodge, in reply, said he had calculated the momentum to be expected in one arrangement of his experiment in which a suspended aluminium cylinder surrounds one limb of a rectangular magnetic circuit which formed the core of an induction coil; one end of the secondary was put to the core and the other to the cylinder, thus forming a condenser. The result came out about 10^{-6} dyne second, but he could not say whether such a small quantity was observable.—On the concentration of electric radiation by lenses, by Prof. O. J. Lodge, F.R.S., and Dr. James L. Howard. The authors' first attempts at concentration were made with mirrors on a comparatively small scale, and, owing to the difficulties experienced, it was considered advisable to try lenses. Two large cylindrical ones of plano-hyperbolic section were cast of mineral pitch in zinc moulds, the plane faces being nearly a metre square, the thickness at vertex 21 centimetres, and each lens weighed about 3 cwt. The eccentricity of the hyperbola was made 1·7, to approximate to the index of refraction of the substance. The lenses were mounted about 6 feet apart, with their plane faces parallel, and towards each other on a table in the College corridor, and an oscillator was placed about the principal focal line of one of them at a distance of 51 centimetres from the vertex. The field was explored by a linear receiver made out of two pieces of copper wire mounted in line on a piece of wood, and the air-gap between their inner ends was adjustable by a screw. When the oscillator worked satisfactorily, the receiver would respond at about 120 centimetres, and with the lenses the distance was 450. The receiver responded anywhere between the lenses, and within the wedge between the second lens and its focal line, the boundaries being clearly defined, but no special concentration was noticed about the focus. Interference experiments were carried out by placing a sheet of metal against the flat face of the second lens, and determining the positions of minimum intensity between the lenses. The distance between these points was 50·5 centimetres, corresponding with a wave-length of 101 centimetres, whereas the calculated wave-length of the oscillator was 100 centimetres. Prof. Fitzgerald congratulated the authors on their success, and also pointed out that although large oscillators give good results at distances within a few wave-lengths, yet at greater distances small ones were decidedly superior, owing to the energy of radiation varying as the fourth power of the rapidity. He had recently made experiments on electric radiations analogous to Newton's rings, and had successfully observed the central dark spot and the first dark band. Referring to Dr. Lodge's experiments, he inquired whether any traces of diffraction were observed near the boundary of the bundle of rays between the lenses. Speaking of polarization experiments, Prof. Fitzgerald said waves reflected from films of water exhibited no polarization, whereas those reflected from non-conductors were completely polarized. In reply, Dr. Lodge said no diffraction-effects had been observed, but in the interference-experiments to determine wave-length, the positions of minimum effect were very decided.—The President, in proposing that the thanks of the meeting be given to the authors of the papers, congratulated the Society on the presence of both Dr. Lodge and Prof. Fitzgerald on the present occasion, when subjects with which they were so well acquainted were brought before the meeting.

Chemical Society, May 2.—Dr. W. J. Russell, F.R.S., President, in the chair.—The following papers were read:—Thiophosphoryl fluoride, by Prof. T. E. Thorpe, F.R.S., and Mr. W. J. Rodger. Thiophosphoryl fluoride, PSF_3, may be prepared by the action of arsenic trifluoride on thiophosphoryl chloride, or by heating a mixture of bismuth trifluoride or lead fluoride with phosphorus pentasulphide in a leaden vessel at a temperature not exceeding 250°. It is a transparent colourless gas, which under a pressure of ten to eleven atmospheres at ordinary temperatures condenses to a colourless, mobile liquid. It is slowly decomposed by water into sulphuretted hydrogen, phosphoric acid, and hydrogen fluoride, but does not attack mercury, and can be stored in a glass gas-holder. In air it is spontaneously inflammable, burning with a greyish-green flame forming phosphorus pentafluoride, phosphorus pentoxide, and sulphur dioxide, and it spontaneously explodes with oxygen. When heated, or subjected to electric sparks, it is decomposed with separation of sulphur and phosphorus, and formation of phosphorus trifluoride, and eventually phosphorus pentafluoride, whilst if the heating be effected in a glass tube at a sufficiently high temperature the gas is ultimately converted into silicon tetrafluoride. Thiophosphoryl fluoride combines with ammonia forming a solid product $P(NH_2)_2SF$, and when shaken with a moderately strong solution of alkali it is absorbed with the formation of a thiophosphate and a fluoride.—The boiling-point of sodium and potassium, by Mr. E. P. Perman. Sodium and potassium were boiled in a hollow iron ball which was heated by means of a blowpipe; the temperature was found in each case by means of an air thermometer consisting of a glass bulb with a capillary stem which was lowered into the vapour, sealed and broken open under water. The mean result for sodium was 742°, and for potassium 667°.—Note on the heat of neutralization of sulphuric acid, by Mr. S. U. Pickering. Calculating the value of the heat of neutralization of sulphuric acid in infinity of water from the results of a series of experiments on the dilution of the acid, the author finds that it becomes reduced to 28,197 cal., a value within experimental error, the same as that of two molecules of hydrogen chloride.—α-ω-diacetylpentane and α ω-dibenzoylpentane, by Dr. F. S. Kipping and Prof. W. H. Perkin.—Acetopropyl- and acetobutyl-alcohol, by Dr. H. G. Colman and Prof. W. H. Perkin.

Royal Meteorological Society, May 15.—Dr. W. Marcet, F.R.S., President, in the chair.—The following papers were read:—Account of some experiments made to investigate the connection between the pressure and velocity of the wind, by Mr. W. H. Dines. These experiments were made for the purpose of determining the relation between the velocity of the wind and the pressure it exerts upon obstacles of various kinds exposed to it. The pressure-plates were placed at the end of the long arm of a whirling machine which was rotated by steam power. The author gives the results of experiments with about twenty-five different kinds of pressure-plates. The pressure upon a plane area of fairly compact form is about 1½ pounds per square foot, at a velocity of twenty-one miles per hour; or, in other words, a pressure of 1 pound per square foot is caused by a wind of a little more than seventeen miles per hour. The pressure upon the same area is increased by increasing the perimeter. The pressure upon a ½-foot plate is proportionally less than that upon a plate either half or double its size. The pressure upon any surface is but slightly altered by a cone or rim projecting at the back, a cone seeming to cause a slight increase, but a rim having apparently no effect.—On an improved method of preparing ozone paper, and other forms of the test, with starch and potassium iodide, by Dr. C. H. Blackley. Some years ago the author made some experiments with the ordinary ozone test-papers, but found that the papers did not always give the same result when two or more were exposed under precisely the same conditions. He subsequently tried what reaction would take place between unboiled starch and potassium iodide when exposed to the influence of ozone; but the difficulty of getting this spread evenly upon paper by hand so as to insure a perfectly even tint after being acted upon by ozone led him to devise a new method of accomplishing this. Briefly described, it may be said to be a method by which the starch is deposited on the surface of the paper by precipitation, and for delicacy and precision in regulating the quantity on any given surface leaves very little to be desired.—Notes on the climate of Akassa, Niger Territory, by Mr. F. Russell. This paper gives the results of observations made from February 1887 to October 1888 at Akassa, which is the seaport and principal depot of the Royal Niger Company, and is situated at the mouth of the River Nun in the Niger Delta.—Wind storm at Sydney, New South Wales, on January 27, 1889, by Mr. H. C. Russell, F.R.S.

Geological Society, May 8.—W. T. Blanford, F.R.S., President, in the chair.—The following communications were read:—The rocks of Alderney and the Casquets, by the Rev. Edwin Hill. The author in this paper described Alderney, Burhou, with its surrounding reefs, and the remoter cluster of the Casquets, all included within an area about ten miles long. The reading of the paper was followed by a discussion, in which the President, Prof. Bonney, Dr. Woodward, Dr. Hicks, and others took part.—On the Ashprington volcanic series of South Devon, by the late Arthur Champernowne. Communicated by Dr. A. Geikie, F.R.S. The author described the general characters of the volcanic rocks that occupy a considerable area of the country around Ashprington, near Totnes. They comprise tuffs and

lavas, the latter being sometimes amygdaloidal and sometimes flaggy and aphanitic. The aphanitic rocks approach in character the porphyritic "schalsteins" of Nassau. Some of the rocks are much altered; the felspars are blurred, as if changing to saussurite, like the felspars in the Lizard gabbros. In other cases greenish aphanitic rocks have, by the decomposition of magnetite or ilmenite, become raddled and earthy in appearance, so as to resemble tuffs. The beds are clearly intercalated in the Devonian group of rocks, and the term Ashprington Series is applied to them by the author. Alrhough this series probably contains some detrital beds, there are no true grits in it. Stratigraphically the series appears to come between the Great Devon Limestone and the Cockington Beds, the evidence being discussed by the author, however, not so fully as he had intended, as the paper was not completed. The President said that the thanks of the Society were especially due to Dr. Geikie for having rescued this paper from oblivion. Dr. Geikie, after alluding to the melancholy interest attaching to the paper, said that he had himself urged the author to formulate his ideas upon the structure of the country. The present communication, however, was all that was found among his papers in a condition for publication. But it is imperfect, and no materials remained from which it could be completed; still it was too valuable a piece of work to leave unpublished. There were two principal points in this last work of Mr. Champernowne: (1) the non-intrusive character of the beds in question; (2) their geological horizon, regarding which, though, owing to the faulted nature of the country, it is rather obscure, Mr. Champernowne's surmises may turn out to be correct. There was no allusion in the paper to the compression and shearing the rocks had undergone, to which he (Dr. Geikie) attributed much of the schistose structure both of the sedimentary and igneous rocks of the region. The flaky beds of which the author speaks can be traced into the more massive rocks. The flattening out of the amygdaloids was a striking proof of this mechanical deformation. Some remarks on the paper were also offered by Mr. Rutley, Dr. Hatch, Mr. Worth, and Mr. W. W. Beaumont.

Zoological Society, May 7.—Prof. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of April 1889, and called attention to a young male Sinaitic Ibex (*Capra sinaitica*), from Mount Sinai, presented by Sir James Anderson; and to a young male of the Lesser Koodoo (*Strepsiceros imberbis*), from East Africa, presented by George S. Mackenzie.—Mr. Sclater exhibited and made remarks on a living specimen of an albino variety of the Cape Mole (*Georychus capensis*), lately presented to the Menagerie by the Rev. George H. R. Fisk, C.M.Z.S.—The Secretary read a letter addressed to him by Dr. E. C. Stirling, of Adelaide, containing a copy of his description of a new Australian burrowing Mammal, lately published in the Transactions of the Royal Society of South Australia, and promising to send to the Zoological Society a more complete account of the same animal.—Mr. Seebohm exhibited and made remarks on the skin of a male example of *Phasianus chrysomelas*, which had been transmitted in a frozen state from the Trans-Caspian Provinces of Russia.—A communication was read from Colonel C. Swinhoe, containing descriptions of seventy-five new species of Indian Lepidoptera, chiefly Heterocera.—A communication was read from Rev. O. P. Cambridge, containing the description of a new Tree Trap-door Spider from Brazil, proposed to be called *Dendricon rostratrum*.—Mr. F. E. Beddard read some notes on the anatomy of an American Tapir (*Tapirus terrestris*), based on a specimen lately living in the Society's Collection.—A communication was read from Prof. Bardeleben, of Jena, on the præpollex and præhallux of the Mammalian skeleton. The author recorded the presence of a two-segmented nail-clad præpollex in *Pedetes*, and that of a two-segmented pisiform (post-minimus) in *Bathyergus*. He also stated that he had discovered vestiges of the præhallux and præpollex in certain Reptilia. He then passed to the consideration of the Mesozoic *Theriodesmus* of Seeley, and denied the existence of the *scapho-lunare* of that author, while he produced good reason for believing the same observer's second *centrale* to consist of two elements, and his præaxial *centrale* to be the basal element of a præhallux.—Mr. Oldfield Thomas read the description of a new genus and species of Muridæ from Queensland, allied to *Hydromys*, which he proposed to call *Xeromys myoides*.

Mathematical Society, May 9.—J. J. Walker, F.R.S., President, in the chair.—The following communications were made:—On the solution in integers of equations of the form $x^3 + y^3 + Az^3 = 0$, by S. Roberts, F.R.S.—On the concomitants of K-ary quantics, by W. J. C. Sharp.—Note on the G function in an elliptic transformation annihilator, by J. Griffiths.—On the complete elliptic integrals K, E, G, I, by Dr. J. Kleiber, *Privat-docent* of the University of St. Petersburg.—On the motion of an elastic solid strained by extraneous forces, by Signor Betti ("by *symmetrical algebraic analysis*, the author obtains an expression, in terms of the rotations of the element, for the unbalanced couples acting on each element of a solid when strained by given forces; and he points out that the result is in accordance with a form of the elastic equations given by Sir W. Thomson").—On cyclotomic functions, § iii. the cyclotomics belonging to the f-nomial periods of the pth roots of unity, where p is a prime number, by Prof. Lloyd Tanner.

EDINBURGH.

Royal Society, April 1.—Sir W. Thomson, President, in the chair.—Prof. Tait communicated some of the results obtained from a series of experiments on impact of various bodies.—Sir W. Thomson exhibited and described new forms of magneto-static current- and volt-meters, and an electro-static voltmeter with a multiple voltaic pile to facilitate graduation.—Mr. A. Crichton Mitchell gave an account of the properties of manganese steel.—Dr. W. Peddie described an improved method of measuring small rotations of the plane of polarization by ordinary apparatus.—Prof. Tait read a paper on the relations between line-, surface-, and volume-integrals. He showed that the well-known relation between line- and surface-integrals can be deduced directly from a particular case of the equally well-known relation between surface- and volume-integrals.

April 15.—Prof. Sir Douglas Maclagan, Vice-President, in the chair.—The Keith Prize for 1885–87 was awarded to Mr. J. Y. Buchanan for a series of communications on subjects connected with ocean circulation, compressibility of glass, &c.—The Makdougall-Brisbane Prize for 1884–86 was awarded to Dr. John Murray for his papers on the drainage areas of continents, and ocean deposits, the rainfall of the globe, and discharge of rivers, the height of the land and depth of the ocean, and the distribution of temperature in the Scottish lochs as affected by the wind.—The Makdougall-Brisbane Prize for 1886–88 was awarded to Dr. Archibald Geikie for numerous communications, especially that on the history of volcanic action during the Tertiary period in the British Isles.—Prof. Swan read an obituary notice of the late Mr. R. M. Smith.—Dr. E. Sang read a paper on the resistance of the air to the motion of an oscillating body with special reference to its effect on time-keepers.—Mr. A. Johnstone communicated a paper on a new and easy method for the rapid and sure detection of mercury.

PARIS.

Academy of Sciences, May 13.—M. Des Cloizeaux, President, in the chair.—The thionic series, by M. Berthelot. In this paper the author studies the action of the acids on the thiosulphates, which throws quite a new light on the constitution of the salts of the thionic series, by determining the limits of the heat of neutralization of thiosulphuric acid. The liberated sulphur reacts with the thiosulphuric acid before it decomposes, forming complex thionic acids.—On mesocamphoric acid, by M. C. Friedel.—The author has prepared this substance by a process different from that of Wreden, by whom it was first described, and some of whose statements are here rectified. Instead of being an inactive, non-decomposable acid, it is found to be decomposable by simple crystallization.—On the photographic spectrum of the great nebula of Orion, by Dr. W. Huggins. In 1882 the author obtained a photograph of the spectrum of this nebula, revealing a new luminous ray with wave-length about $\lambda 3730$. Two recent photographs taken in 1888 and 1889 enable him to determine more accurately this wave-length, as well as to describe a certain number of other luminous rays which occur in the ultra-violet region of the spectrum of the same nebula. These photographs are figured in a drawing which accompanies the present note. The wave-length of the bright ray discovered in 1882 is here determined at $\lambda 3724$. Dr. Huggins considers it probable that nebulæ yielding a spectrum of luminous rays, with a very faint continuous spectrum, which is probably formed in part by luminous rays in close proximity, are at or near the beginning of the cycle of their celestial evolution, while those resembling the large nebula in Andromeda have already reached a more

advanced phase of their development. The photograph of this nebula taken by Mr. Roberts reveals a planetary system, in which some planets are already formed, and their central mass condensed.—On the surgical treatment of the foot in cases of suppurated osteo-arthritis, by M. Ollier. Hitherto amputation has generally been considered the only remedy; but the author's experiments show that, by removal of the ankle with abrasion or resection of the limiting articulations, the foot may be preserved almost in its normal state and with little detriment to its locomotive functions.—On the linear expansion of solid bodies at high temperatures, by M. Pionchon. These researches show that by means of the simple process here described M. Fizeau's well-known experiments may be repeated with the greatest ease. M. Pionchon now proposes to apply the process to the study of the linear expansion of amorphous and crystallized solid bodies at high temperatures.—On the direct measurement of the retardation produced by the reflection of luminous waves, by M. A. Potier. These experiments, which are applicable to a large number of substances, constitute a method by means of which the retardation may be directly measured, which is caused by the reflection of the luminous waves on their surface.—On the influence of terrestrial magnetism on atmospheric polarization, by M. Henri Becquerel. In a previous memoir (*Annales de Chimie et de Physique*, xix., 1880) the author showed that in a cloudless sky the plane of polarization is not generally coincident with the theoretic plane (plane of the sun), and further that the two should coincide when the latter is vertical, but that, in a region near the horizon and the magnetic meridian, the plane of polarization then deviates by a small angle in the direction corresponding to the rotation of the plane of polarization of a luminous ray traversing a column of air, subject to the magnetic influence of the earth. In the present paper he determines both the direction and the extent of the rotation, and also shows how this display of terrestrial magnetism is associated with some of the most interesting questions connected with the physics of the globe.—A study of the electric conductivity of saline solutions, as applied to chemical mechanics—the acid salts, by M. P. Chroustchoff. The author has applied M. Bouty's extremely sensitive electrometric method of measuring the electric conductivity of liquids to the study of several problems in chemical statics. In the present paper he tabulates the chief measurements of the electric conductivity of aqueous solutions containing one salt only.—Action of the atmosphere on manganese carbonate, by M. A. Gorgeu. In this paper the author discusses the question whether this action can give rise to any of the natural dioxides, as assumed by MM. Boussingault and Dieulafait.—Papers were contributed by M. L. Pigeon, on platinic chloride; by M. Aug. Lambert, on the action of borax on the polyhydric phenols and alcohols; and by M. H. Prouho, on the structure and metamorphosis of *Flustrella hispida*.—A copy of M. Seligmann-Lui's translation of Clerk Maxwell's classical treatise on "Electricity and Magnetism" was presented to the Academy by M. Sarrau.

BERLIN.

Physical Society, April 26.—Prof. Kundt, President, in the chair.—Prof. Kundt gave a short account of recent researches on electro-magnetic rotatory polarization, and developed the more general point of view from which they had been respectively undertaken. Since the time when Faraday discovered the fundamental phenomena and later physicists had accumulated a mass of material on which observations could be made, two facts had chiefly presented difficulties in connection with the established theory: of these one was the varying direction of rotation produced by different substances, some producing a positive rotation (in the direction of the Ampèrian current), others a negative rotation; the other fact was the absence of magnetic rotation in doubly-refractive crystals. Starting from some theoretical considerations, the speaker was led to surmise that rotation is not wanting in these crystals, but is only obscured by some opposing phenomenon, a view which has been fully confirmed by experiments carried out at his suggestion by Drs. Wedding, Wiener, and du Bois. When a piece of glass was made doubly refractive by pressure, its magnetic rotatory polarization diminished, becoming *nil* when the difference in path of the two rays was $\frac{1}{2}\lambda$; when the difference was $\frac{3}{4}\lambda$, then the rotation took place in the opposite direction. When the difference was λ, the rotation was again *nil*, and it varied thus in a wave-like manner, with increasingly small amplitudes until it ceased entirely. Prof. Kundt concluded from this that the power of electro-magnetic rotatory polarization is common to *all* substances, whether crystalline or isotropous. As regards the varying direction of rotation, his own experiments had shown that simple substances produce a positive rotation, and compound bodies a negative rotation; this last result may be explained by the fact that the Ampèrian currents inside compound bodies run in a direction different from that in the magnetic field. The proportionality of rotation to the strength of magnetization is also a property common to all substances; its relationship to refraction is being made the subject of further researches. Dr. Koenig (from Leipzig) pointed out many analogies which exist between the electrical rays discovered by Prof. Hertz and rays of light, more particularly the polarization of the electrical rays by means of the wire grating and the phenomena which may be observed in the immediate neighbourhood of the rays as they are advancing in straight lines, phenomena which are in exact accord with those described by Stokes in the case of light.

STOCKHOLM.

Royal Academy of Sciences, April 9.—Researches on the deviations of the plumb line in Sweden, by Prof. Rosén.—Résumé préliminaire d'une recherche expérimentale sur l'absorption de la chaleur rayonnante par les gaz atmosphériques, by Dr. Ångström.—Newly found specimens of *Anser brachyrhynchus*, Baill., in Sweden, by Dr. A. Stuxberg.—On a singular Tetrarhynchid larva, by Herr E. Lönnberg.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Eclectic Physical Geography: R. Hinman (Low).—A Treatise on the Principles of Chemistry, 2nd edition: M. M. P. Muir (Cambridge University Press).—Teutonic Mythology: V. Rydberg, translated by R. B. Anderson (Sonnenschein).—Die Entstehung der Arten durch Räumliche Sonderung: M. Wagner (Basel, B. Schwabe).—Examination of Water for Sanitary and Technical Purposes: H. Leffmann and W. Beam (Philadelphia, Blakiston).—Hourly Readings, 1886, Part 3, July to September (Eyre and Spottiswoode).—The Uses of Plants: G. S. Boulger (Roper and Drowley).—Journal of the Institution of Electrical Engineers, No. 79, vol. xviii. (Spon).—Quarterly Journal of the Geological Society, No. 178 (Longmans).—Ergebnisse der Meteorologischen Beobachtungen, Jahrg. x. (Hamburg).

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